

AN ESTIMATE OF JUVENILE SOCKEYE SALMON
(Oncorhynchus nerka) DENSITIES IN SKILAK AND
KENAI LAKES, ALASKA THROUGH THE USE OF DUAL BEAM
HYDROACOUSTIC TECHNIQUES

by

Kenneth E. Tarbox
and
Bruce E. King

Regional Information Report¹ No. 2S-88-17

Alaska Department of Fish and Game
Division of Commercial Fisheries
P.O. Box 3150
Soldotna, Alaska 99669

April 1988

¹Contribution 88-2 from the Soldotna Area office. The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate needs for up-to-date information, reports in this series may contain preliminary data.

AREA DATA REPORTS: This series of reports is designed to facilitate archiving of small data sets and internal agency information. It generally consists of data sets of less significant nature that frequently are combined on an annual basis and published through the ADF&G Technical Data Report Series. This series also includes noteworthy field observation, feasibility studies, Board of Fisheries Reports and staff meeting notes. To promote documentation of as many observations as possible which would otherwise remain unreported, this informal report series receives very little editing, thus caution is recommended in use of data and any analysis presented within.

TABLE OF CONTENTS

| <u>Section</u> | <u>Page</u> |
|------------------------|-------------|
| ABSTRACT | 1 |
| INTRODUCTION | 2 |
| METHODS | 3 |
| RESULTS | 5 |
| DISCUSSION | 7 |
| ACKNOWLEDGMENTS | 12 |
| LITERATURE CITED | 13 |
| APPENDICES | 49 |

LIST OF FIGURES

| <u>Figure</u> | <u>Page</u> |
|--|-------------|
| 1. The Upper Cook Inlet area showing the location of the Northern and Central Districts and the major sockeye salmon spawning drainages | 28 |
| 2. The Kenai River drainage, Alaska and the location of the major lake systems which are utilized by rearing sockeye salmon | 29 |
| 3. Skilak Lake, Alaska area designations, hydroacoustic transect locations, and tow netting stations, 1986 | 30 |
| 4. Kenai Lake, Alaska area designations, hydroacoustic transect locations, and tow netting stations, 1986 | 31 |
| 5. Length frequency of sockeye salmon collected in Kenai Lake, Alaska during October 1986 | 32 |
| 6. In situ target strength measurements and proportion by depth strata collected from Kenai Lake, Alaska, September 1986. (Note: the proportion of targets was scaled by 1/range ²) | 33 |
| 7. In situ target strength measurements and proportion by depth strata collected from Skilak Lake, Alaska, October 1986. (Note: the proportion of targets was scaled by 1/range ²) | 34 |
| 8. Horizontal fish distribution (mean density/1000m ²) measured in Skilak Lake, Alaska during October 1986: (a) Area 1, Transects 1 and 2; (b) Area 2, Transects 3 and 4; and (c) Area 3, Transects 5 and 6. Sequence group 1 is north shore | 35 |
| 9. Horizontal fish distribution (mean density/1000m ²) measured in Kenai Lake, Alaska during September 1986: (a) Area 1, Transects 9A, 8, 7, 6; (b) Area 2, Transects 11A, 10, 10A, 9; and (c) Area 3, Transects 13A, 12, 12A, 11. Sequence group 1 is north shore | 36 |
| 10. Horizontal fish distribution (mean density/1000m ²) measured in Kenai Lake, Alaska during September 1986: (a) Area 4, Transects 13, 14A, 14, 15A; and (b) Area 5, Transects 15, 16A, 16, 17, 18, 19. Sequence group 1 is north shore | 37 |

LIST OF FIGURES (Continued)

| <u>Figure</u> | <u>Page</u> |
|---|-------------|
| 21. Vertical distribution of fish density measured during the hours of daylight in Kenai Lake, Alaska (Area 5: Transects 15, 16, 18, 19) in September 1986 | 48 |

LIST OF APPENDIX TABLES (Continued)

| <u>Table</u> | <u>Page</u> |
|---|-------------|
| 13. Hydroacoustic estimate of fish inhabiting Area 1, Kenai Lake, Alaska based on Transect 8 (night survey) integrator output | 61 |
| 14. Hydroacoustic estimate of fish inhabiting Area 1, Kenai Lake, Alaska based on Transect 9A (night survey) integrator output | 62 |
| 15. Hydroacoustic estimate of fish inhabiting Area 2, Kenai Lake, Alaska based on Transect 9 (night survey) integrator output | 63 |
| 16. Hydroacoustic estimate of fish inhabiting Area 2, Kenai Lake, Alaska based on Transect 10A (night survey) integrator output | 64 |
| 17. Hydroacoustic estimate of fish inhabiting Area 2, Kenai Lake, Alaska based on Transect 10 (night survey) integrator output | 65 |
| 18. Hydroacoustic estimate of fish inhabiting Area 2, Kenai Lake, Alaska based on Transect 11A (night survey) integrator output | 66 |
| 19. Hydroacoustic estimate of fish inhabiting Area 3, Kenai Lake, Alaska based on Transect 11 (night survey) integrator output | 67 |
| 20. Hydroacoustic estimate of fish inhabiting Area 3, Kenai Lake, Alaska based on Transect 12A (night survey) integrator output | 68 |
| 21. Hydroacoustic estimate of fish inhabiting Area 3, Kenai Lake, Alaska based on Transect 12 (night survey) integrator output | 69 |
| 22. Hydroacoustic estimate of fish inhabiting Area 3, Kenai Lake, Alaska based on Transect 13A (night survey) integrator output | 70 |
| 23. Hydroacoustic estimate of fish inhabiting Area 4, Kenai Lake, Alaska based on Transect 13 (night survey) integrator output | 71 |
| 24. Hydroacoustic estimate of fish inhabiting Area 4, Kenai Lake, Alaska based on Transect 14A (night survey) integrator output | 72 |

LIST OF APPENDIX TABLES (Continued)

| <u>Table</u> | <u>Page</u> |
|--|-------------|
| 37. Hydroacoustic estimate of fish inhabiting Area 2, Kenai Lake, Alaska based on Transect 9 (day survey) integrator output | 88 |
| 38. Hydroacoustic estimate of fish inhabiting Area 2, Kenai Lake, Alaska based on Transect 10 (day survey) integrator output | 89 |
| 39. Hydroacoustic estimate of fish inhabiting Area 3, Kenai Lake, Alaska based on Transect 11 (day survey) integrator output | 90 |
| 40. Hydroacoustic estimate of fish inhabiting Area 3, Kenai Lake, Alaska based on Transect 12 (day survey) integrator output | 91 |
| 41. Hydroacoustic estimate of fish inhabiting Area 4, Kenai Lake, Alaska based on Transect 13 (day survey) integrator output | 92 |
| 42. Hydroacoustic estimate of fish inhabiting Area 4, Kenai Lake, Alaska based on Transect 14 (day survey) integrator output | 93 |
| 43. Hydroacoustic estimate of fish inhabiting Area 5, Kenai Lake, Alaska based on Transect 15 (day survey) integrator output | 94 |
| 44. Hydroacoustic estimate of fish inhabiting Area 5, Kenai Lake, Alaska based on Transect 16 (day survey) integrator output | 95 |
| 45. Hydroacoustic estimate of fish inhabiting Area 5, Kenai Lake, Alaska based on Transect 18 (day survey) integrator output | 96 |
| 46. Hydroacoustic estimate of fish inhabiting Area 5, Kenai Lake, Alaska based on Transect 19 (day survey) integrator output | 97 |

ABSTRACT

The number and distribution of sockeye salmon (Oncorhynchus nerka) rearing in two glacial lakes (Skilak and Kenai Lakes, Alaska) was estimated from hydroacoustic surveys conducted in the fall of 1986. Application of a dual beam acoustic system during the survey allowed the collection of in situ target strength (and backscattering cross section) information for scaling of the echo integrator outputs to absolute fish density.

The average target strength of fish sampled in Skilak and Kenai Lakes was -53.78 dB and -55.35 dB, respectively. Statistically significant differences in target strength were measured between 5 m depth strata for both lakes.

Approximately 21.5 million fry were estimated to inhabit Skilak Lake, with the majority (68%) located in the western third of the lake. In contrast, Kenai Lake was estimated to contain approximately 4.5 million fish and fish distribution was consistent with that observed in Skilak Lake (62% of the fish were located in the western third of the lake). The depth distribution of rearing fry was similar in both lakes with the highest densities of fish found 15 m below the surface. Tow netting of the lakes indicated that 97% and 88% of the targets were age-0 sockeye salmon in Kenai and Skilak Lakes, respectively.

Comparison of the results of a survey of Kenai Lake during the day with the results of an evening survey indicated strong surface orientation of rearing sockeye salmon during the day.

The estimate of rearing sockeye salmon fry from these glacial lakes will be used to develop a forecast methodology for adult return to the drainage.

KEY WORDS: hydroacoustic survey, sockeye salmon, target strength, glacial lake, Alaska.

INTRODUCTION

The commercial salmon fishing industry within the State of Alaska is a multi-million dollar industry which requires factual and accurate information on the status of the fishery resource. Of particular significance to the industry is the forecast of returning adult salmon to the fishery. This information is used for a variety of planning purposes including securing loans, planning market strategy, setting starting prices for the raw product, and establishing operational dates and logistical requirements. In this context, the State of Alaska annually provides a statewide forecast of salmon returns to the fishing industry (Eggers 1986).

For Upper Cook Inlet, Alaska (Figure 1) the forecast of adult sockeye salmon (Oncorhynchus nerka) returns is based on spawner/return relationships (Tarbox and Waltemyer 1986). Unfortunately, the data base is limited to just a few years of returns because the glacial character of the major sockeye salmon systems prohibited the enumeration of spawning adults until the early 1970's when refinement of hydroacoustic techniques allowed counts to be made (Tarbox et al. 1983). In addition, a forecast of returns based strictly on adult spawners is subject to extreme variability and assumptions regarding density dependent factors (Ricker 1954). Ideally, the enumeration of migrating sockeye salmon smolt as they exit these river systems would document freshwater production and provide data to establish a second relationship to adult spawners. However, the glacial nature and size of the major sockeye salmon producing systems in Upper Cook Inlet makes a smolt enumeration project cost prohibitive. Therefore, a secondary forecast technique independent of adult spawner/return relationships and/or smolt enumeration was desired.

Recent advances in the field of hydroacoustic enumeration of rearing sockeye salmon fry in lake systems provided an alternative to smolt enumeration. The use of hydroacoustic techniques for this purpose was initially tried in the 1960's (Rogers 1967), but the limitations of the acoustic equipment made this approach appear unsuccessful. However, technological advances since those early days have resulted in numerous successful applications of hydroacoustic equipment for estimating juvenile sockeye salmon densities in lakes (Thorne et al. 1975; Thorne and Woodey 1970; Dawson 1972; Nunnallee and Mathisen 1972; Lemberg 1975; Thomas 1980; Thorne and Thomas 1982, 1983, 1984; Thomas et al. 1986 [a, b], 1987). The development of in situ target strength measurements by application of a dual beam hydroacoustic system (Ehrenberg 1974; Burczynski and Dawson 1984; Traynor and Ehrenberg 1979) has significantly expanded the opportunity to refine echo integration for estimates of absolute abundance (average backscattering cross section is now available in situ). Burczynski and Johnson (1986) recently reported the successful application of this approach for Cultus Lake, British Columbia.

Obtaining an estimate of the number of rearing sockeye salmon fry also provides the opportunity to augment biological information on rearing sockeye salmon in glacial lake systems of Alaska. Historically, biological data have been based primarily on methods which provide catch per unit effort data (notably tow nets and fish traps). These methods suffer primarily from limitations on effort, but also are affected by fish density, distribution,

based on: 1) ease of transecting during the night; and 2) the results of Kimura and Lemberg (1981) who reported that stratified methods of sampling (i.e., zig zag) were uniformly more efficient than random parallel sampling, especially at low sampling intensities.

The hydroacoustic equipment for survey data acquisition consisted of a Biosonics, Inc. Model 105 echo sounder with dual beam receivers, a 420 kHz, 6/15 degree dual beam transducer mounted in a towed body, a Model 171 tape recorder interface, a Sony model SL-HF400 video cassette recorder and PCM-501ES digital audio processor, a Model 115 chart recorder, and a Model 315P oscilloscope. The selected pulse width was 0.4 milliseconds (ms) and the ping rate varied from 5-6 pings/second (additional acoustic parameters used during data collection and processing are presented in Appendix Table 1). The system was calibrated at Biosonics, Inc. prior to and following the survey. The entire system was powered by batteries and the equipment was housed in a 22 foot vessel powered by a 150 hp outboard motor. Transect speed was estimated at 2.7 meters/second (m/s) and beginning and end points of the transects were marked with flashing lights prior to darkness. The towed body was approximately 1 m below the surface during transecting.

Data reduction and analysis was facilitated by the use of microcomputers and associated software. Dual beam data were processed through a Biosonics, Inc. Model 181 dual beam processor. A returning pulse was accepted as a valid target if the amplitude of the pulse was below the bottom threshold of 5000 millivolt (mV; -36dB) and above the threshold level of 98 mV (-70dB). Single targets were separated from multiple targets if the pulse width was within 20% of the transmitted pulse width at -6 decibels (dB). The beam pattern threshold was selected at -4 dB. Data stored by the dual beam processor were transferred to microcomputer data files for analysis using Biosonics, Inc. software program TS112 (revised). Computation of target strengths and backscattering cross sections were made and printed out by preselected 5 m depth intervals. Individual echos were used to calculate the mean target strength.

Estimates of fish density were made for each transect by echo integration using a Biosonics, Inc. Model 120 echo integrator (representative echograms for each lake are presented in Appendix Figures 1-4). Correction from the 40 log(R) setting used during data collection to 20 log(R) for data processing was accomplished by adjusting the B constant value for each depth strata (Appendix Table 1). The TVG crossover for the system was 2.7 m. The depth strata selected for analysis were 5 m increments starting 2 m below the transducer (3 m below the water surface). Data were processed to 52 m and 97 m below the transducer in Kenai and Skilak Lakes, respectively (visual examination of oscilloscope and chart recordings indicated no fish present below these depths). Voltages from returning echoes were averaged in 1-minute sequences along each transect and the integrator outputs were transferred to diskettes for further reduction and analysis through use of Biosonics, Inc. software entitled Crunch (version 2.43). Fish density was obtained by averaging the integrator output values across the transect by depth strata and multiplying by the integrator scaling factor (derived from mean backscattering cross section obtained with the dual beam processor). The mean backscattering cross section value was selected by depth strata from the transect of interest. In the case where the sample size for establishing

deviation of 4.74 dB ($n = 21,519$; Appendix Table 2). Skilak Lake measurements were similar with a mean target strength of -53.78 dB with a standard deviation of 4.69 dB ($n = 25,157$; Appendix Table 3). Of the echos measured, approximately 5,215 and 5,302 had beam pattern factors greater than 0 dB for Kenai and Skilak Lakes, respectively (80% were within the range of 0 to 1 dB). Graphic representation of the data by depth for both lakes is presented in Figures 6 and 7. An apparent pattern of decreasing target strength with depth was evident in the data set. Within Kenai Lake, surface measurements (2-7 m) averaged -52.34 dB, decreasing consistently to -58.24 dB for the 42 m - 72 m depth strata (Appendix Table 2). Similarly, surface measurements decreased from -50.63 dB near the surface to -55.42 dB at 37 - 42 m depth in Skilak Lake (Appendix Table 3). Test of the hypothesis of no difference in target strength with depth for each transect resulted in the rejection of the hypothesis for all Skilak Lake transects and 18 of the 22 Kenai Lake transects (alpha 0.05; Appendix Table 4).

As previously noted, the estimation of the total number of fish in the lake systems was derived from the summation of three components: a) the actual measurement of fish targets during the hours of darkness by hydroacoustic techniques (Table 2); b) the estimate of those fish in the surface waters above the transducer (Table 3); and c) the estimate of fish below the bottom window of the data processing equipment (Table 4). The total estimate of fish in Skilak and Kenai Lakes was 21,452,000 and 4,493,800 fish, respectively (Table 5).

Relative to the spatial distribution of fish within the lake systems, a pattern was observed with most of the fish located near the western end of the lakes. Approximately 68% or 14,675,000 fish were located in Area 1 of Skilak Lake, which comprised 43.5% of the surface area of the lake and 26.1% of the volume sampled (Table 6). Within Kenai Lake, 62% of the fish were located within Areas 1 and 2 which were estimated to be 35.4% of the surface area of the lake and 31.9% of the volume sampled. Lowest densities of fish were observed at the eastern end of each lake. Only 3% of the fish were located in Area 5 of Kenai Lake, which was 19.7% and 19.4% of the surface area and volume sampled, respectively. The same distribution was observed in Skilak Lake with only 9% of the fish found in Area 3 which was 22.7% and 30.1% of the surface area and volume (Table 6). Individual transect estimates of volume and fish numbers by depth strata for each lake are presented in Appendix Tables 5 through 32.

Further analysis of the horizontal distribution of fish was accomplished by the vertical summation of fish densities for five individual one minute sequences and computation of a mean fish density per 1000 square meters (Appendix Tables 33 and 34; Figures 8 through 10). Within Skilak Lake, the maximum fish density (1,360 fish/1000 square meters) was recorded on Transect 1 near the north shore of the lake. However, consistently higher relative fish densities were observed on the south shore of the lake for Transects 1-4 (Figure 8). Relatively equal densities across the lake were observed for Transects 5 and 6 and, consistent with the volume estimates, the surface estimates were indicative of lower fish numbers at the upper end of the lake (Figure 8). Considerably lower fish densities were measured in Kenai Lake with a range of measurements from 0/1000 square meters (Transect 18) to a high of 476/1000 square meters along Transect 10 (Appendix Table 34; Figure 9). No obvious distributional patterns across the lake were evident in the

non-representative sampling is certainly possible. For example, the zig-zag pattern of sampling essentially represents large areas of the nearshore region on the basis of transects which converge together. In addition, the bias associated with surface and bottom orientation of fish is not well defined. Within the present investigation, the surface and bottom corrections comprised approximately 20% of the total estimate (both lakes) and 22% of the Skilak Lake estimate. Refinement in data processing by closer bottom tracking and the use of an upward looking transducer to further evaluate surface orientation may be warranted. However, the midwater orientation of most of the fish during surveying makes the error associated with these phenomena less significant than a strong surface orientation (which was observed during the Kenai Lake day survey).

The use of a zig zag sampling design, while allowing greater tracking distance, limits the use of the calculated variance to an illustrative value only. The calculated variance estimated from between transect variation assumes that the transects were randomly selected or that the population is randomly distributed (Jolly and Hampton, in press). These assumptions are not met and, therefore, the variance calculation should be viewed accordingly. Jolly and Hampton (in press) suggest that systematic samples may have a slight gain in precision compared to random samples but the variance will be correspondingly overestimated if it is estimated by formula appropriate to a random sample.

The parameters used to calculate the integrator scaling factor are an additional source of potential error. In an attempt to minimize this, the hydroacoustic equipment was calibrated before and after the survey and no major system errors were documented. Potentially, the most significant source of error is associated with the estimate of the fish mean backscattering cross section. The results of this investigation appear to be reasonable relative to the size frequency distribution of the fish sampled when compared with published target strength data for juvenile sockeye salmon. For example, Burczynski and Johnson (1986) reported a target strength of -52.3 dB for 45-mm sockeye salmon. McClain (1985), using a dual beam system in Tustumena Lake, Alaska, reported a target strength of -53.0 dB for 45-mm age-0.0 sockeye salmon. Using the empirical formula of Love (1977), the target strength of the fish captured in Skilak and Kenai Lakes, at 45 degrees orientation, would be -51.89 and -52.62 dB, respectively.

The apparent decrease in target strength with depth in both lake systems is not explainable at this time. The hydroacoustic equipment, specifically the TVG correction, appeared to be accurate and stable during data collection. Therefore, the decrease in target strength with depth may represent a biological phenomena, or the potential loss of signal associated with the glacial nature of the environment (i.e., absorption loss). While no data presently exist to verify the potential for absorption loss, varying target strength values resulting from biological factors such as species differences, orientation or tilt angle, and age composition changes with depth, have been documented on numerous occasions in other systems. In either event, the analysis of data in discrete 5 m depth intervals minimized the impact of change in target strength with range.

Inherent in the preceding presentation of results is the assumption that most of the fish targets measured were sockeye salmon. This assumption was based

Lake compare favorably with these values. However, the Kenai Lake estimate is only 45% of the predicted value. If consistently lower numbers are documented in future investigations, the results may imply that Kenai Lake is spawning limited, although the authors are not suggesting this here.

The sizes of juvenile sockeye salmon measured in both Kenai and Skilak Lakes are consistent with previous tow net results (Tarbox et al. 1984). While the relatively small size of juvenile sockeye salmon can be indicative of a density dependent rearing limitation, this relationship for glacial systems is questionable. Koenings et al. (1986) suggested that density independent factors may be as important in limiting fish production. Within glacial lakes, the temperature regime of the lake appears to be critical to fry growth and survival (Koenings et al. 1986). Therefore, the population estimates for both Kenai and Skilak Lakes, combined with the size frequency data, should not be construed to mean a system at rearing capacity.

The observation of near surface distribution of juvenile sockeye salmon in a glacial lake system was initially reported by Thorne and Thomas (1982). Within Tustumena Lake, they observed that diel variability in juvenile sockeye salmon density was most obvious in September (i.e., higher fish densities were measured in the upper 10 m during the day). They hypothesized that this unusual diel pattern was an effect of reduced hours of daylight in the fall on the feeding behavior of sockeye salmon. The present investigation tends to verify the surface orientation of juvenile sockeye salmon during the hours of daylight. No data exist to verify the hypothesis of a feeding response to light levels. However, the euphotic zone within Kenai Lake has been estimated at approximately 7 m, which would suggest that the availability of light is severely limited.

In summary, the utilization of the dual beam hydroacoustic system, within the glacial lake systems of the Kenai River drainage, has increased the data base significantly on the abundance and spatial distribution of rearing sockeye salmon. The ultimate use of these data as a forecast tool is yet to be decided. However, of equal importance is the increased knowledge future fishery biologists will gain on the salmon rearing abilities of these lake systems.

In an effort to improve the sampling program, the following recommendations are suggested for future investigations:

- (1) the sampling design should be modified to use a random design. Because of the apparent differences in density between geographic locations within the lake, a stratified random sample of parallel transects is recommended. This design meets the statistical requirements necessary for variance calculations (Jolly and Hampton, in press);
- (2) further investigation into the reason for the target strength distribution is needed. If absorption loss occurred because of glacial silt or some other unknown factor, it could impact future investigations in a number of lake systems in Alaska;
- (3) tow netting results were not satisfactory and, therefore, alternate sampling techniques should be explored;

ACKNOWLEDGEMENTS

We wish to thank the staff of BioSonics, Inc. for their support and help during the data collection and analysis phase of this project. Special thanks is extended to Janusz Burczynski for his understanding and tolerance with the authors while instructing us on the proper use of BioSonic equipment and for review of the manuscript. In addition, our appreciation is extended to Jim Dawson, Sam Johnson, and Bruce Ransom for their input during analysis of the data.

Within the Department of Fish and Game we would like to acknowledge Chuck Meacham and Ken Florey for their support in funding the project and allowing us to venture into a new area. Finally, a special thanks to Dave Waltemyer for helping in the tow netting of juvenile sockeye salmon and general consultation.

LITERATURE CITED (Continued)

- Koenings, J.P., R.D. Burkett, G.B. Kyle, J.A. Edmundson, and J.M. Edmundson. 1986. Trophic level responses to glacial meltwater intrusion in Alaskan lakes. American Water Resources Association Cold Regions Hydrology Symposium, July 1986: 179-194.
- Lemberg, N.A. 1975. Hydroacoustic assessment of the 1973 sockeye salmon escapement into Lake Quinault, Washington. Masters Thesis, University of Washington, Seattle.
- Love, R.H. 1971. Target strength of an individual fish at any aspects. Journal of the Acoustic Society of America. 62:1397-1403.
- McClain, J.C. 1985. An application of new dual beam technology for hydroacoustic investigations in fisheries. Marine Technological Society.
- Nunnallee, E.P., and O.A. Mathisen. 1972. An acoustic survey of Lake Wenatchee, Washington. University of Washington, Fisheries Research Institute Circular 72-13. Seattle.
- Ricker, W.E. 1954. Stock and recruitment. Journal of the Fisheries Research Board of Canada 11:559-623.
- Rogers, D.E. 1967. Estimation of pelagic fish populations in the Wood River lakes, Alaska, from tow net catches and echogram marks. Doctoral Dissertation, University of Washington, Seattle.
- Scott, K.M. 1982. Erosion and sedimentation in the Kenai River, Alaska. Geological Survey Professional Paper 1235.
- Tarbox, K.E. and D.L. Waltemyer. 1986. History and evaluation of sockeye salmon escapement goals for the Kenai, Kaslof, and Susitna Rivers, Upper Cook Inlet. Alaska Department of Fish and Game, Division of Commercial Fisheries, Upper Cook Inlet Data Report 86-4, Anchorage.
- Tarbox, K.E., L.B. Flagg, L.C. Van Ray and J. Dean. 1984. Sockeye salmon investigations, Tustumena Lake system, Alaska. Progress Report No. 2. Alaska Department of Fish and Game, Commercial Fisheries Division and Fisheries Rehabilitation, Enhancement and Development Division. Upper Cook Inlet Data Report 84-5, Anchorage.
- Tarbox, K.E., B.E. King and D.L. Waltemyer. 1983. Cook Inlet sockeye salmon studies. Alaska Department of Fish and Game, Division of Commercial Fisheries, Completion Report, July 1, 1977 to June 30, 1982, Anchorage.
- Thomas, G.L. 1980. Hydroacoustic measurement of fish density on Ozette Lake, spring 1979 to summer 1980. Contract Report to the Makah Tribe. Seattle.

Table 1. Species composition and mean length at age of fish captured by tow net in Kenai and Skilak Lakes, Alaska, 1986.

| Location | Dates of Sampling | Number of Stations Sampled | Minutes of Towing | Species | EFFORT | | Sample Size | | Mean Length (FL) ¹ | |
|-------------|-------------------|----------------------------|-------------------|---------|--------|---|-------------|-------|-------------------------------|-------|
| | | | | | | | Age 0 | Age 1 | Age 0 | Age 1 |
| | | | | | % | % | Count | Mean | Count | Mean |
| Kenai Lake | 10/13/86 | 4 | 210 | Sockeye | # | % | 227 | 8 | 52 | 74 |
| | | | | | | | 96.6 | 3.4 | | |
| Skilak Lake | 10/7, 15/86 | 13 | 810 | Sockeye | # | % | 15 | 2 | 57 | 77 |
| | | | | | | | 88.2 | 11.8 | | |
| | | | | Coho | | | 1 | | | 42 |

¹ FL - fork length

Length measured in millimeters.

One threespine stickleback also taken in Skilak Lake.

Table 2, continued. The estimated number of fish in Kenai and Skilak Lakes, Alaska as determined from acoustic surveys in the fall of 1986.

| Lake | Area | Transect | Estimated Number of Fish | Variance |
|-----------------|------|----------|--------------------------|------------|
| Kenai | 5 | 15 | 1.9046E+05 | |
| | | 16a | 2.1138E+05 | |
| | | 16 | 7.9762E+04 | |
| | | 17 | 3.1140E+04 | |
| | | 18 | 8.1657E+04 | |
| | | 19 | 1.3087E+05 | |
| | | mean | 1.2088E+05 | 4.8828E+09 |
| TOTAL ALL AREAS | | | 4.2035E+06 | 2.2271E+12 |

Table 3, continued. Estimated number of fish not available to the hydroacoustic equipment because of surface orientation in Skilak and Kenai Lakes, Alaska during the fall of 1986.

| Lake | Area | Transect | Estimated Fish Density (number/m ³) | Estimated Volume (m ³) | Estimated Number of Fish | Variance |
|-----------------|------|----------|---|--|--------------------------------|------------|
| Kenai | 5 | 15 | 0.0000E+00 | 3.2790E+07 | 0.0000E+00 | |
| | | 16a | 2.1000E-03 | 3.2790E+07 | 6.8859E+04 | |
| | | 16 | 1.7000E-03 | 3.2790E+07 | 5.5743E+04 | |
| | | 17 | 3.0000E-05 | 2.7325E+07 | 8.1975E+02 | |
| | | 18 | 5.2000E-04 | 3.2790E+07 | 1.7051E+04 | |
| | | 19 | 4.6000E-04 | 3.2790E+07 | 1.5083E+04 | |
| | | mean | | | 2.6259E+04 | 8.4609E+08 |
| TOTAL ALL AREAS | | | | | 2.9024E+05 | 4.3125E+10 |

¹ Fish density was estimated from visual extrapolation of measured fish densities 2 m below the transducer to the surface. In the event densities were estimated at 0.0 prior to the surface, the depth of the strata was adjusted to reflect only that portion which contained fish.

Table 4, continued. Estimated number of fish not available to the hydroacoustic equipment because of bottom orientation in Skilak Lake, Alaska during the fall of 1986.

| Area | Transect | Bottom Depth(m) | Fish Density (number/m^3) | Estimated Volume (m^3) | Estimated Number of Fish | Estimated Variance | |
|---------------------------|----------|-----------------|------------------------------|---------------------------|--------------------------|--------------------|--|
| 2 | 3 | 2-7 | 7.1560E-04 | 0.0000E+00 | 0.0000E+00 | | |
| | | 7-12 | 5.3200E-03 | 1.1950E+06 | 6.3574E+03 | | |
| | | 12-17 | 8.5310E-03 | 0.0000E+00 | 0.0000E+00 | | |
| | | 17-22 | 8.9660E-03 | 0.0000E+00 | 0.0000E+00 | | |
| | | 22-27 | 5.1970E-03 | 1.1950E+06 | 6.2104E+03 | | |
| | | 27-32 | 2.5990E-03 | 0.0000E+00 | 0.0000E+00 | | |
| | | 32-37 | 7.9380E-04 | 2.3900E+06 | 1.8972E+03 | | |
| | | 37-42 | 4.3360E-05 | 1.1950E+06 | 5.1815E+01 | | |
| | | 42-47 | 2.8910E-05 | 0.0000E+00 | 0.0000E+00 | | |
| | | 47-52 | 4.6970E-05 | 1.1950E+06 | 5.6129E+01 | | |
| | | 52-57 | 2.9970E-05 | 0.0000E+00 | 0.0000E+00 | | |
| | | 57-62 | 6.4468E-05 | 2.3900E+06 | 1.5459E+02 | | |
| | | 62-67 | 2.0510E-05 | 0.0000E+00 | 0.0000E+00 | | |
| | | 67-72 | 2.6680E-05 | 0.0000E+00 | 0.0000E+00 | | |
| | | 72-77 | 1.8570E-05 | 0.0000E+00 | 0.0000E+00 | | |
| | | 77-82 | 7.2890E-06 | 0.0000E+00 | 0.0000E+00 | | |
| | | 82-87 | 1.8970E-06 | 0.0000E+00 | 0.0000E+00 | | |
| | | 87-92 | 2.0160E-06 | 1.1950E+06 | 2.4091E+00 | | |
| | | 92-97 | 1.7440E-05 | 1.1950E+06 | 2.0841E+01 | | |
| TOTAL | | | | | 1.4751E+04 | | |
| 2 | 4 | 2-7 | 8.2290E-05 | 0.0000E+00 | 0.0000E+00 | | |
| | | 7-12 | 4.0610E-03 | 1.5933E+06 | 6.4705E+03 | | |
| | | 12-17 | 8.0270E-03 | 1.5933E+06 | 1.2790E+04 | | |
| | | 17-22 | 6.9480E-03 | 0.0000E+00 | 0.0000E+00 | | |
| | | 22-27 | 5.1520E-03 | 0.0000E+00 | 0.0000E+00 | | |
| | | 27-32 | 1.7150E-03 | 0.0000E+00 | 0.0000E+00 | | |
| | | 32-37 | 6.0870E-04 | 0.0000E+00 | 0.0000E+00 | | |
| | | 37-42 | 1.3320E-04 | 0.0000E+00 | 0.0000E+00 | | |
| | | 42-47 | 1.9740E-05 | 0.0000E+00 | 0.0000E+00 | | |
| | | 47-52 | 1.0370E-04 | 0.0000E+00 | 0.0000E+00 | | |
| | | 52-57 | 2.5280E-04 | 0.0000E+00 | 0.0000E+00 | | |
| | | 57-62 | 1.6010E-04 | 3.1867E+06 | 5.1019E+02 | | |
| | | 62-67 | 1.1690E-04 | 0.0000E+00 | 0.0000E+00 | | |
| | | 67-72 | 1.0230E-04 | 1.5933E+06 | 1.6300E+02 | | |
| | | 72-77 | 8.2000E-05 | 0.0000E+00 | 0.0000E+00 | | |
| | | 77-82 | 1.9410E-05 | 0.0000E+00 | 0.0000E+00 | | |
| | | 82-87 | 7.7360E-06 | 0.0000E+00 | 0.0000E+00 | | |
| | | 87-92 | 0.0000E+00 | 1.5933E+06 | 0.0000E+00 | | |
| | | 92-97 | 0.0000E+00 | 1.5933E+06 | 0.0000E+00 | | |
| TOTAL | | | | | 1.9933E+04 | | |
| MEAN OF TRANSECTS 3 AND 4 | | | | | 1.7342E+04 | 1.3430E+07 | |

Continued

Table 4, continued. Estimated number of fish not available to the hydroacoustic equipment because of bottom orientation in Skilak Lake, Alaska during the fall of 1986.

¹ No estimate was made for Kenai Lake as the shoreline was extremely steep and not a significant component of the sample volume.

Table 5, continued. The estimated number of fish in Skilak and Kenai Lakes, Alaska based on actual hydroacoustic measurements and corrections for bias associated with surface and bottom areas in the fall of 1986.

| Lake | Area | Estimation Parameter | Estimated Number of Fish | Variance |
|-------------------------|------|----------------------|--------------------------|------------|
| Kenai | 5 | Surface | 2.6259E+04 | 8.4609E+08 |
| | | Midwater | 1.2088E+05 | 4.8828E+09 |
| | | Bottom | 0.0000E+00 | 0.0000E+00 |
| | | Total | 1.4714E+05 | 5.7289E+09 |
| All | All | Surface | 2.9025E+05 | 4.3125E+10 |
| | | Midwater | 4.2035E+06 | 2.2271E+12 |
| | | Bottom | 0.0000E+00 | 0.0000E+00 |
| | | Total | 4.4938E+06 | 2.2702E+12 |
| TOTAL COMBINED ESTIMATE | | | 2.5945E+07 | 2.1194E+13 |

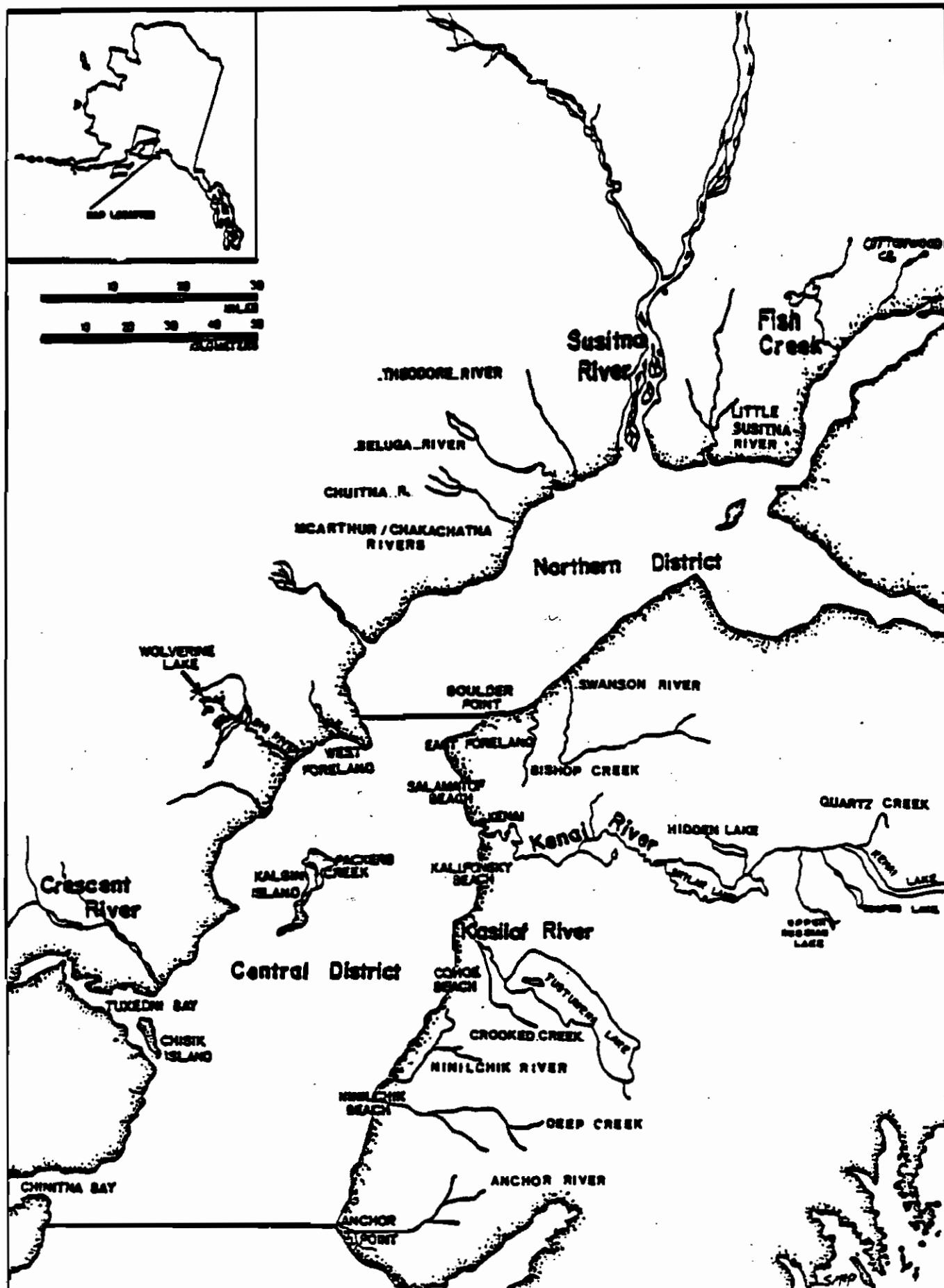


Figure 1. The Upper Cook Inlet area showing the location of the Northern and Central Districts and the major sockeye salmon spawning drainages .

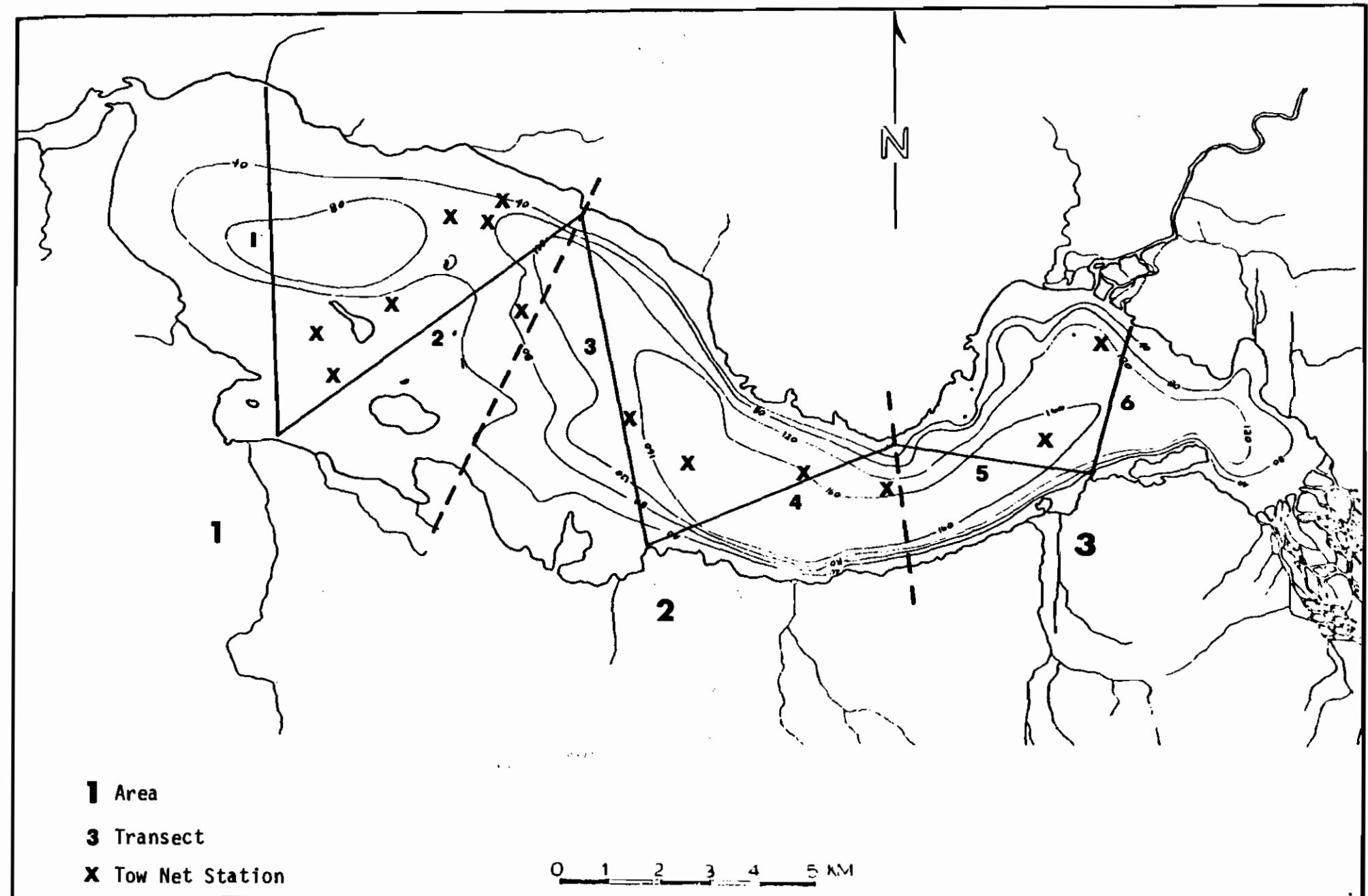


Figure 3. Skilak Lake, Alaska area designations, hydroacoustic transect locations, and tow netting stations, 1986.

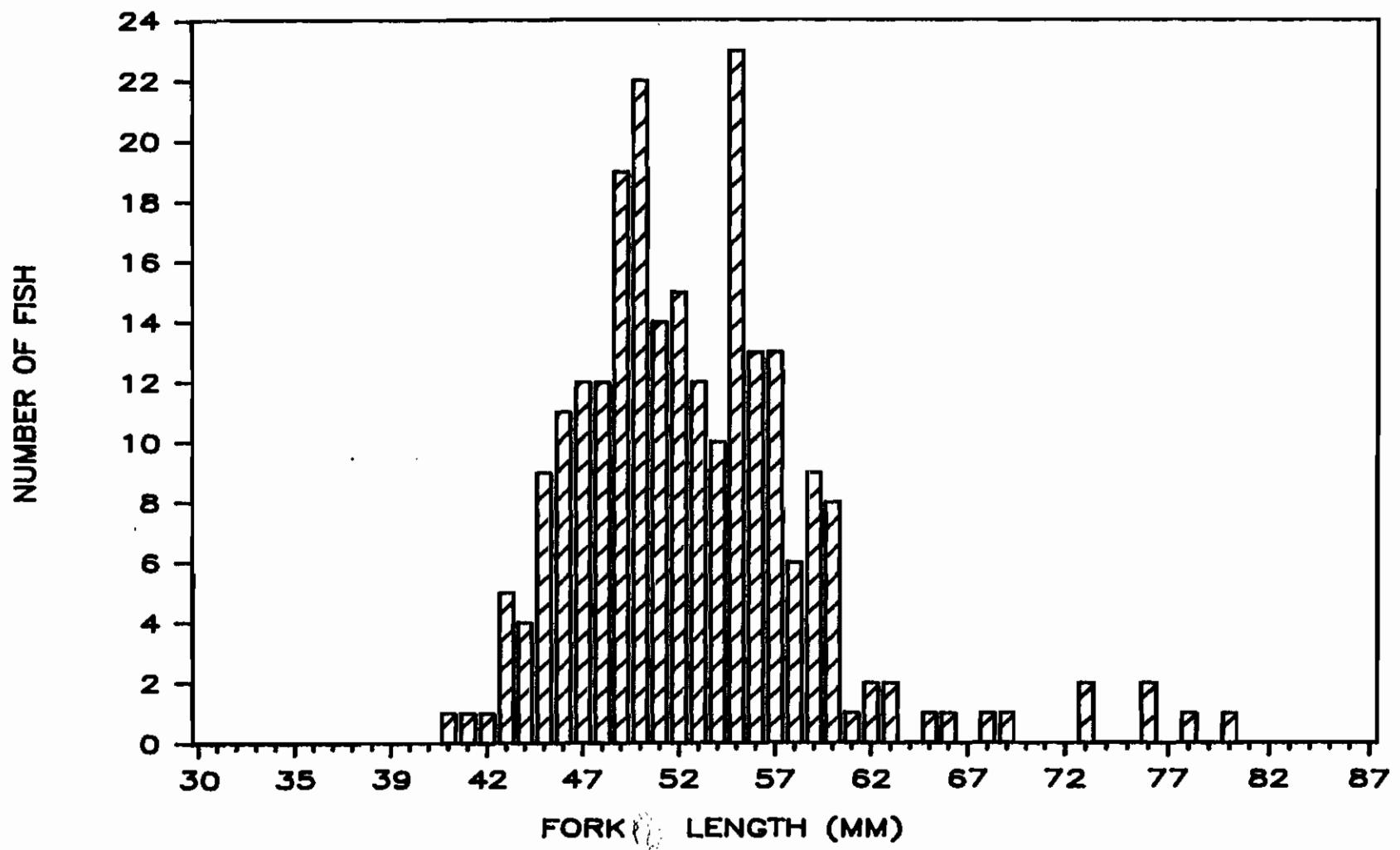


Figure 5. Length frequency of sockeye salmon collected in Kenai Lake, Alaska during October 1986.

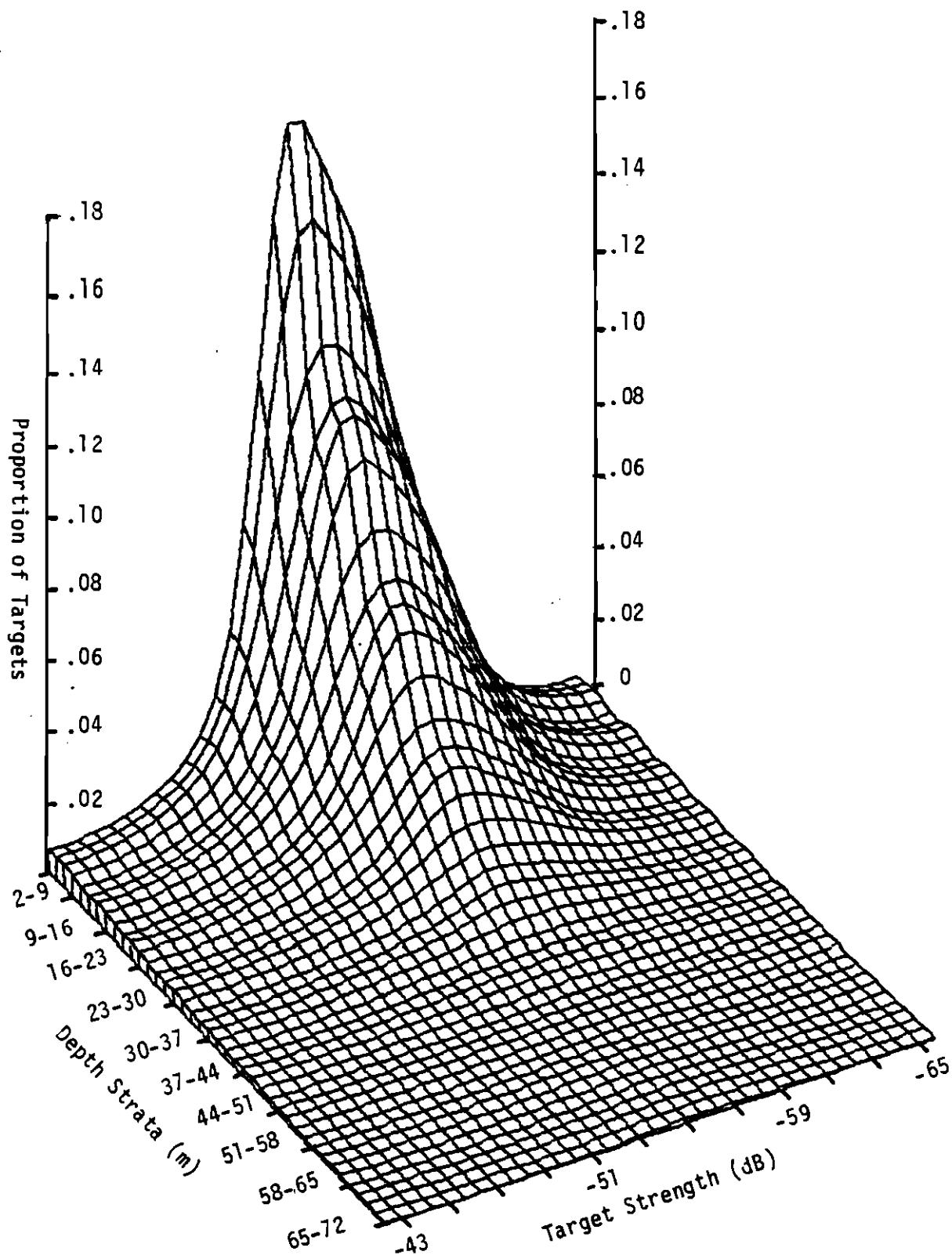


Figure 7. In situ target strength measurements and proportion by depth strata collected from Skilak Lake, Alaska, October 1986. (Note: the proportion of targets was scaled by 1/range²).

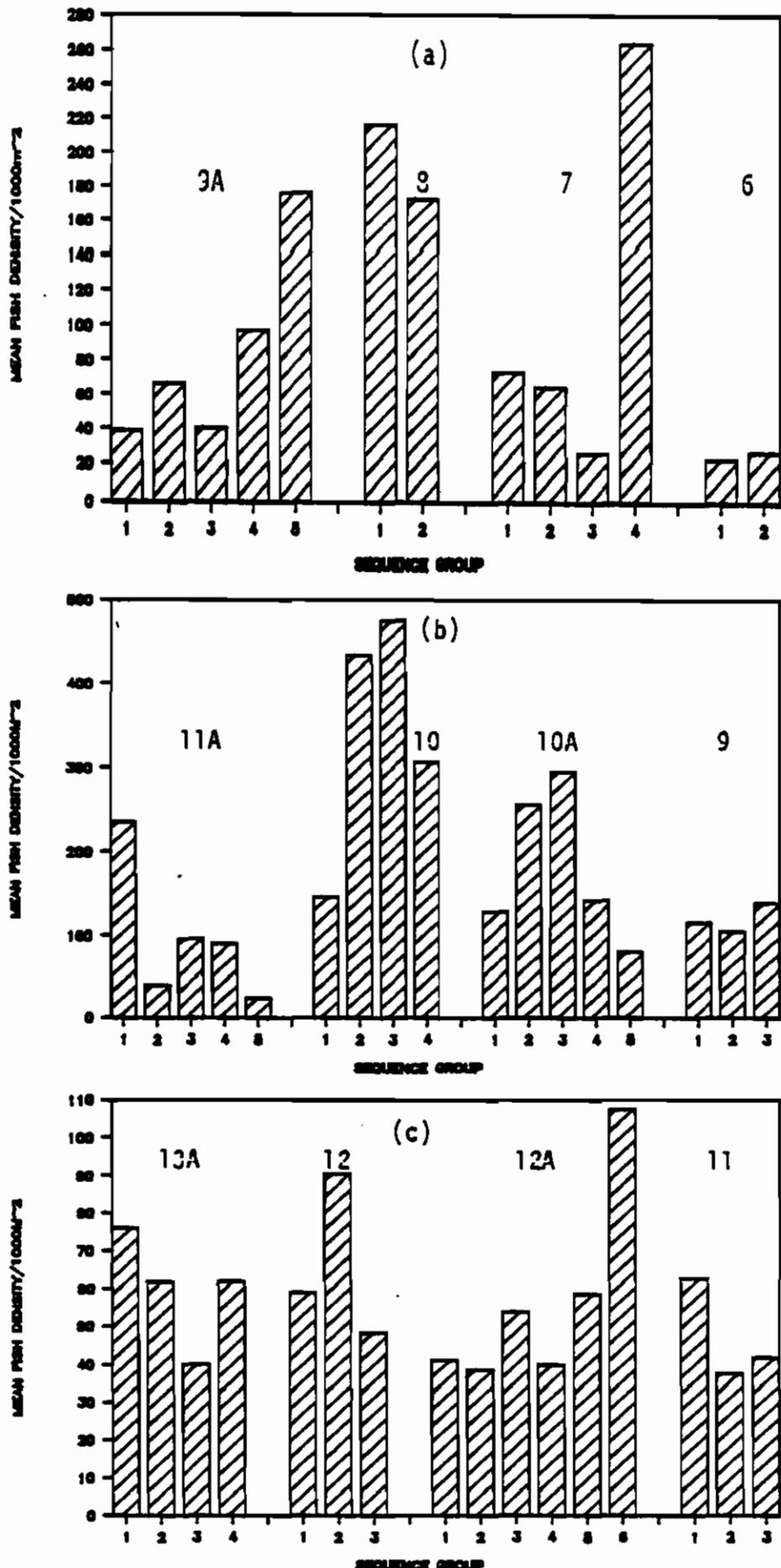


Figure 9. Horizontal fish distribution (mean density/1000m²) measured in Kenai Lake, Alaska during September 1985: (a) Area 1, Transects 9A, 8, 7, 6; (b) Area 2, Transects 11A, 10, 10A, 9; and (c) Area 3, Transects 13A, 12, 12A, 11. Sequence group 1 is north shore.

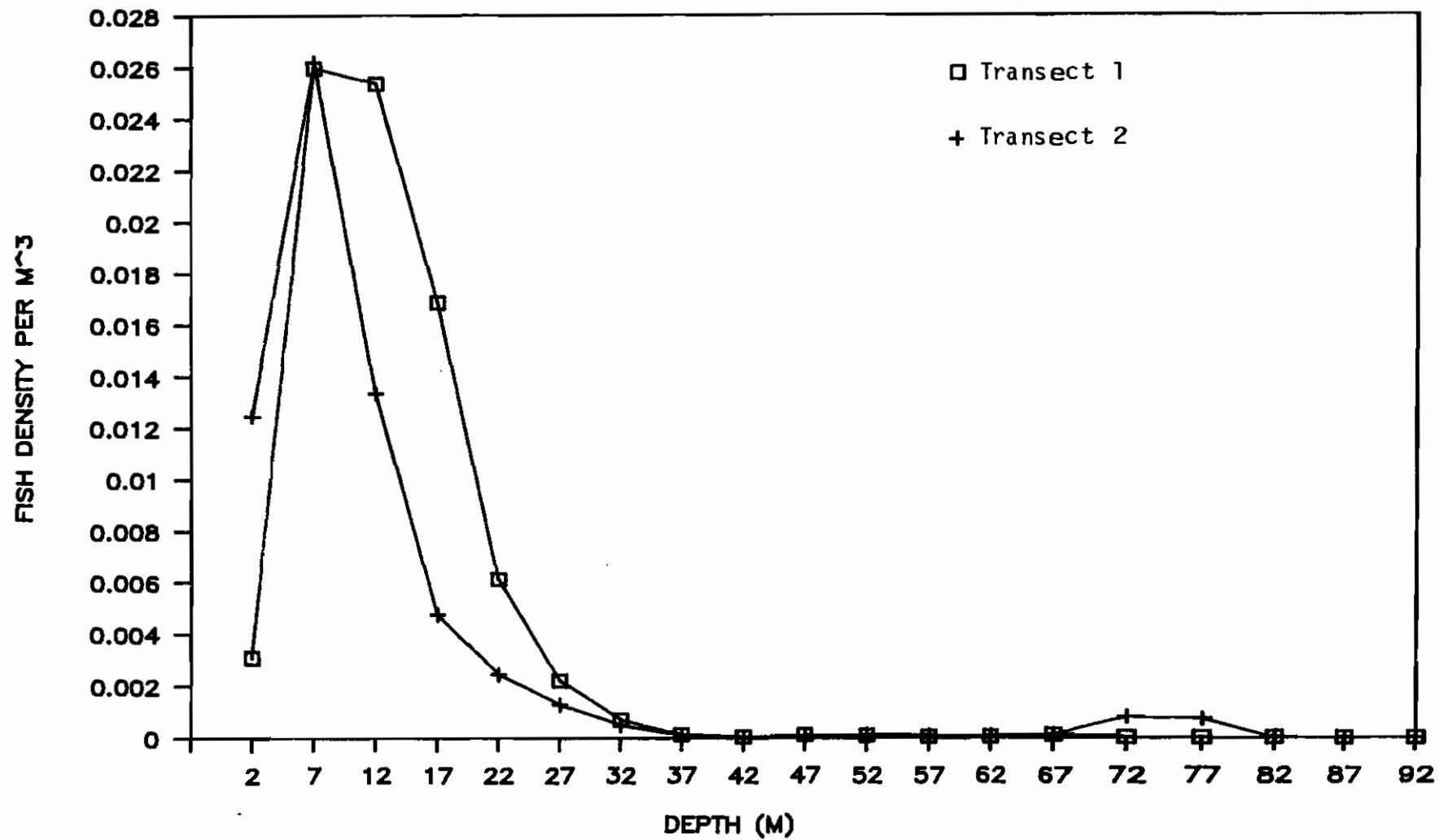


Figure 11. Vertical distribution of fish density measured during the hours of darkness in Skilak Lake, Alaska (Area 1: Transects 1 and 2) in October 1986.

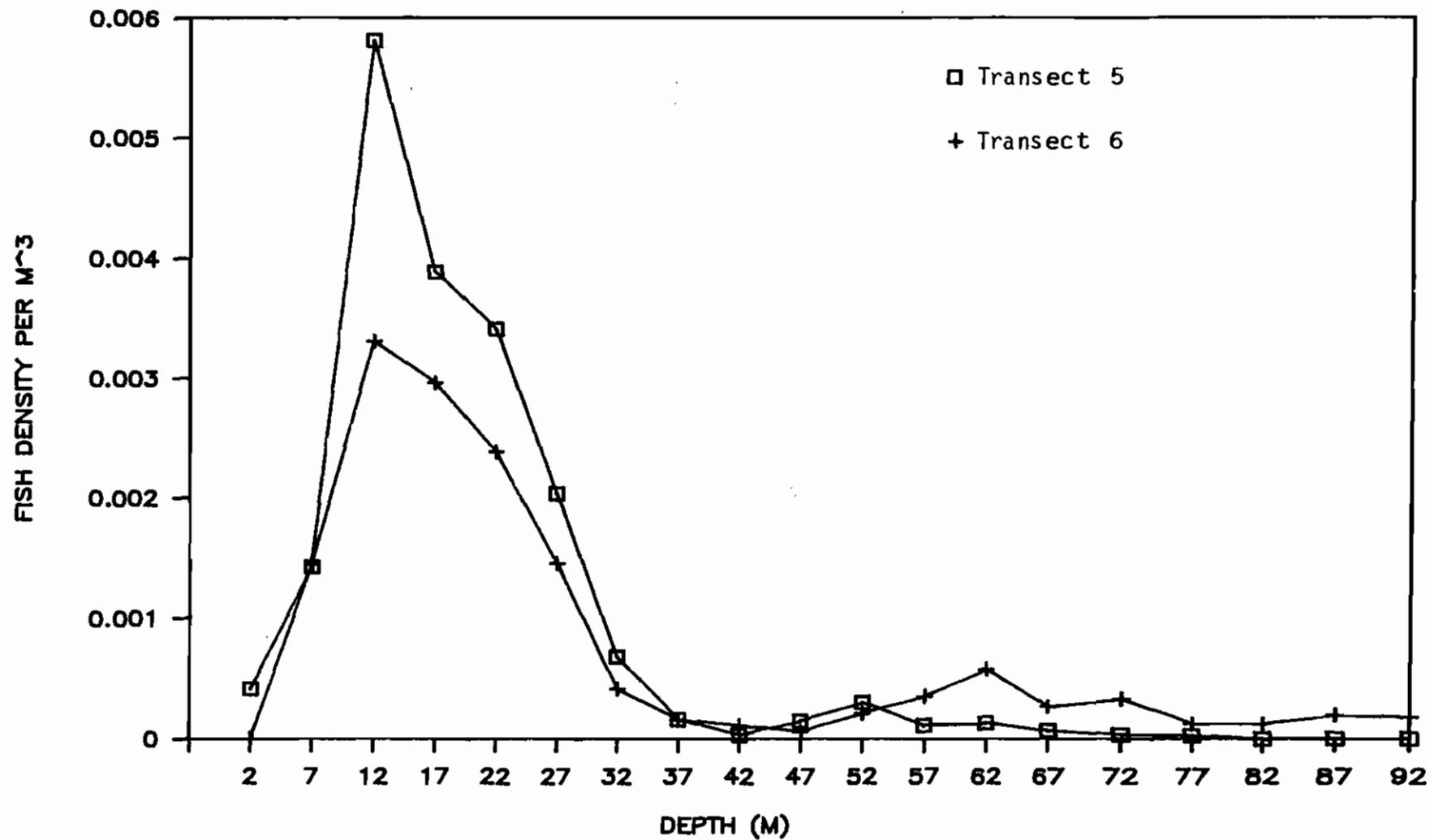


Figure 13. Vertical distribution of fish density measured during the hours of darkness in Skilak Lake, Alaska (Area 3: Transects 5 and 6) in October 1986.

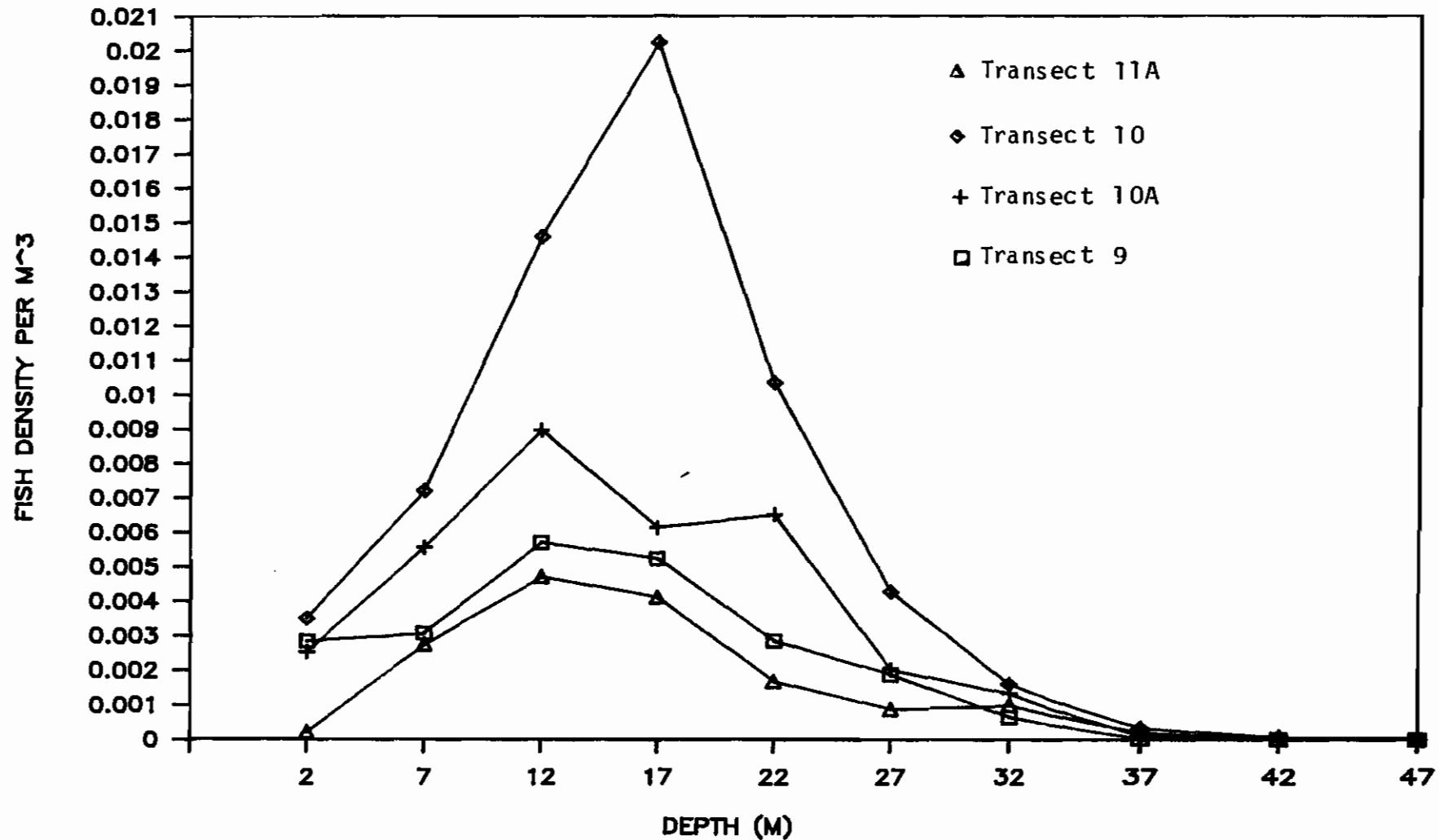


Figure 15. Vertical distribution of fish density measured during the hours of darkness in Kenai Lake, Alaska (Area 2: Transects 9, 10A, 10, 11A) in September 1986.

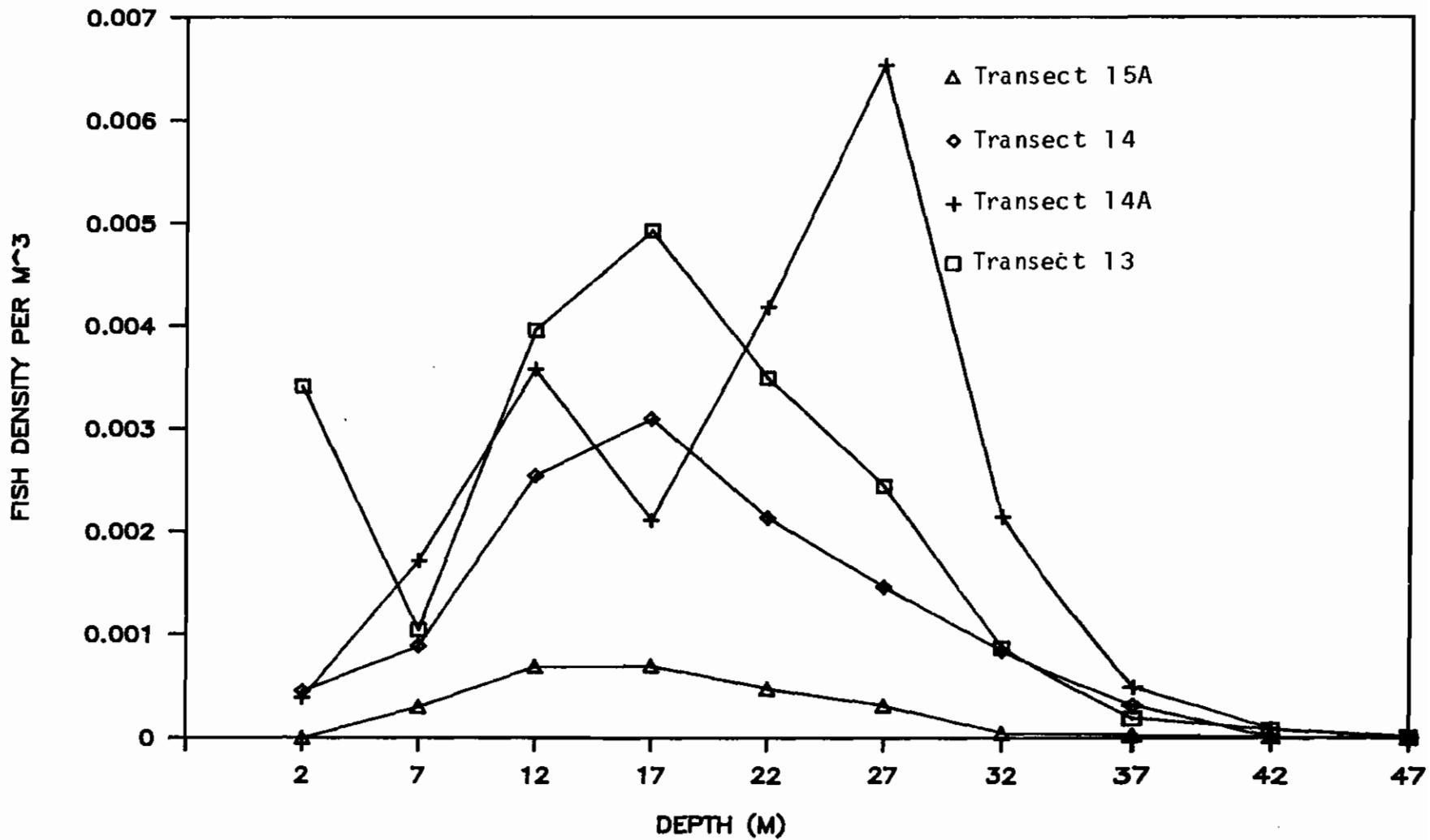


Figure 17. Vertical distribution of fish density measured during the hours of darkness in Kenai Lake, Alaska (Area 4: Transects 13, 14A, 14, 15A) in September 1986.

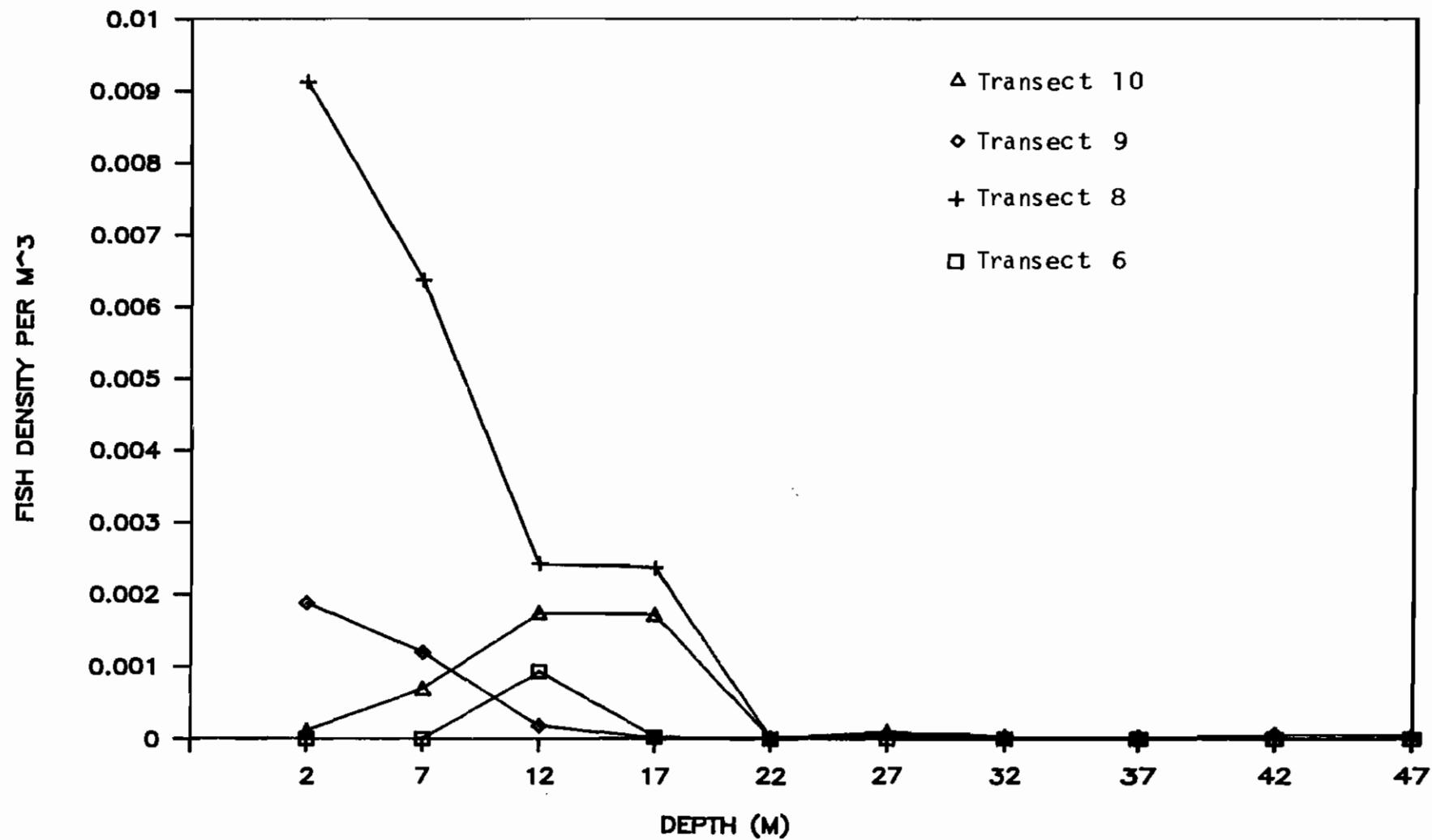


Figure 19. Vertical distribution of fish density measured during the hours of daylight in Kenai Lake, Alaska (Areas 1 and 2: Transects 6, 8, 9, 10) in September 1986.

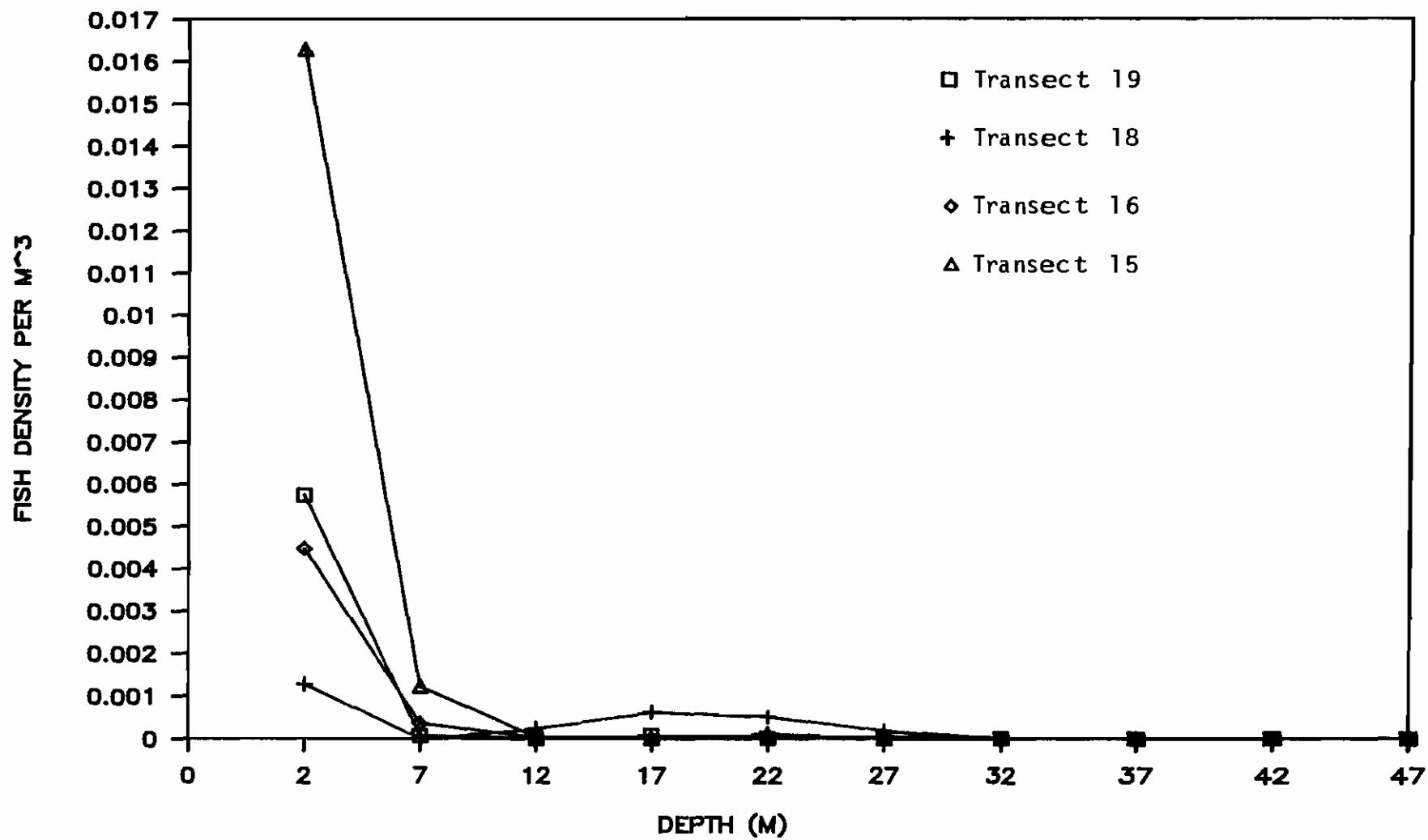


Figure 21. Vertical distribution of fish density measured during the hours of daylight in Kenai Lake, Alaska (Area 5: Transects 15, 16, 18, 19) in September 1986.

Appendix Table 2. Average backscattering cross section (σ)
and target strength data by depth strata for
all transects combined, Kenai Lake, Alaska, 1986.

| Depth Stratum (m) | Number of Targets | Sigma Mean | Sigma Standard Deviation | Target ¹ Strength Mean (dB) | Target Strength Standard Deviation (dB) |
|----------------------|-------------------|------------|--------------------------|---|---|
| 2.0 - 7.0 | 177 | 1.050E-05 | 1.061E-05 | -52.34 | 5.19 |
| 7.0 - 12.0 | 1258 | 1.115E-05 | 4.339E-05 | -53.38 | 5.42 |
| 12.0 - 17.0 | 3306 | 6.476E-06 | 8.420E-06 | -54.56 | 5.08 |
| 17.0 - 22.0 | 4648 | 5.261E-06 | 5.994E-06 | -55.22 | 4.85 |
| 22.0 - 27.0 | 4383 | 4.486E-06 | 4.258E-06 | -55.61 | 4.59 |
| 27.0 - 32.0 | 3789 | 4.100E-06 | 3.595E-06 | -55.77 | 4.40 |
| 32.0 - 37.0 | 2695 | 3.724E-06 | 3.805E-06 | -56.11 | 4.23 |
| 37.0 - 42.0 | 1101 | 3.460E-06 | 2.998E-06 | -56.28 | 4.04 |
| 42.0 - 47.0 | 195 | 2.970E-06 | 2.089E-06 | -56.57 | 3.66 |
| 47.0 - 72.0 | 57 | 1.969E-06 | 1.593E-06 | -58.24 | 3.20 |
| Total | 21519 | 5.166E-06 | 1.188E-05 | -55.35 | 4.74 |

¹ Target strength determined from dual beam data collected in situ.

Appendix Table 4. Summary of analysis of variance of target strength data by depth strata for Kenai and Skilak Lakes, Alaska, 1986.

| Lake | Transect Number | Sample Size (N) | Number Strata (k) | Degrees of Freedom | | | Calculated F Value | Table F Value | Degrees of Freedom | | | Null Hypothesis |
|--------|-----------------|-----------------|-------------------|--------------------|-------|--|--------------------|---------------|--------------------|----------|--|-----------------|
| | | | | Groups | Error | | | | Groups | Error | | |
| Kenai | 19 | 135 | 6 | 5 | 129 | | 4.42 | 2.29 | 5 | 125 | | reject |
| | 18 | 28 | 3 | 2 | 25 | | 4.51 | 3.38 | 2 | 25 | | reject |
| | 17 | 48 | 4 | 3 | 44 | | 2.57 | 2.82 | 3 | 44 | | accept |
| | 16 | 46 | 6 | 5 | 40 | | 1.71 | 2.45 | 5 | 40 | | accept |
| | 16A | 332 | 6 | 5 | 326 | | 5.21 | 2.23 | 5 | 400 | | reject |
| | 15 | 88 | 6 | 5 | 82 | | 1.15 | 2.30 | 5 | 100 | | accept |
| | 15A | 303 | 7 | 6 | 296 | | 5.23 | 2.13 | 6 | 300 | | reject |
| | 14 | 662 | 7 | 6 | 655 | | 6.58 | 2.10 | 6 | 1000 | | reject |
| | 14A | 2307 | 8 | 7 | 2299 | | 14.38 | 2.01 | 7 | infinity | | reject |
| | 13 | 1525 | 7 | 6 | 1518 | | 8.89 | 2.09 | 6 | infinity | | reject |
| | 13A | 913 | 7 | 6 | 906 | | 3.71 | 2.10 | 6 | 1000 | | reject |
| | 12 | 381 | 9 | 8 | 372 | | 6.81 | 1.96 | 8 | 400 | | reject |
| | 12A | 1360 | 7 | 6 | 1353 | | 6.83 | 2.09 | 6 | infinity | | reject |
| | 11 | 536 | 7 | 6 | 529 | | 0.77 | 2.10 | 6 | 1000 | | accept |
| | 11A | 1736 | 7 | 6 | 1729 | | 9.12 | 2.09 | 6 | infinity | | reject |
| | 10 | 3229 | 7 | 6 | 3222 | | 5.98 | 2.09 | 6 | infinity | | reject |
| | 10A | 3065 | 7 | 6 | 3058 | | 6.47 | 2.09 | 6 | infinity | | reject |
| | 9 | 1172 | 6 | 5 | 1166 | | 12.18 | 2.09 | 6 | infinity | | reject |
| | 9A | 1460 | 7 | 6 | 1453 | | 20.83 | 2.09 | 6 | infinity | | reject |
| | 8 | 545 | 4 | 3 | 541 | | 19.30 | 2.61 | 3 | infinity | | reject |
| | 7 | 1403 | 5 | 4 | 1398 | | 32.81 | 2.37 | 4 | infinity | | reject |
| | 6 | 222 | 5 | 4 | 217 | | 5.49 | 2.41 | 4 | 200 | | reject |
| Skilak | 1 | 6240 | 10 | 9 | 6230 | | 28.67 | 1.88 | 9 | infinity | | reject |
| | 2 | 4156 | 10 | 9 | 4146 | | 41.22 | 1.88 | 9 | infinity | | reject |
| | 3 | 5690 | 10 | 9 | 5680 | | 30.10 | 1.88 | 9 | infinity | | reject |
| | 4 | 4547 | 10 | 9 | 4537 | | 13.18 | 1.88 | 9 | infinity | | reject |
| | 5 | 2344 | 10 | 9 | 2334 | | 5.84 | 1.88 | 9 | infinity | | reject |
| | 6 | 2132 | 10 | 9 | 2122 | | 6.55 | 1.88 | 9 | infinity | | reject |

¹ Sample size represents the number of echoes processed. Alpha is at 0.05 level.

Appendix Table 6. Hydroacoustic estimate of fish inhabiting Area 1, Skilak Lake, Alaska based on Transect 2 integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Confidence Limits | | |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|----------------------|------------|------------|
| | | | | | | | | | | Variance | (95%) | |
| 2.0 - 7.0 | 1.9460E+08 | 1.4170E-05 | 478 | 1.3610E-05 | 1.8190E+02 | 6.8620E-05 | 55 | 5.0660E-10 | 1.2490E-02 | 2.4294E+06 | 6.4630E+11 | 1.5760E+06 |
| 7.0 - 12.0 | 1.4840E+08 | 1.2660E-05 | 1245 | 1.3780E-05 | 2.0370E+02 | 1.2880E-04 | 50 | 7.2130E-10 | 2.6220E-02 | 3.8918E+06 | 6.7320E+11 | 1.6080E+06 |
| 12.0 - 17.0 | 1.0500E+08 | 9.3640E-06 | 713 | 1.0030E-05 | 2.7530E+02 | 4.8460E-05 | 33 | 1.9380E-10 | 1.3340E-02 | 1.4013E+06 | 1.6520E+11 | 7.9670E+05 |
| 17.0 - 22.0 | 9.1270E+07 | 6.8430E-06 | 474 | 6.5000E-06 | 3.7680E+02 | 1.2680E-05 | 26 | 8.1120E-12 | 4.7780E-03 | 4.3608E+05 | 9.9550E+09 | 1.9560E+05 |
| 22.0 - 27.0 | 8.2320E+07 | 7.1640E-06 | 390 | 6.3820E-06 | 3.5990E+02 | 6.8440E-06 | 23 | 9.3120E-13 | 2.4630E-03 | 2.0275E+05 | 9.0080E+08 | 5.8830E+04 |
| 27.0 - 32.0 | 7.3770E+07 | 5.1060E-06 | 271 | 4.3270E-06 | 5.0490E+02 | 2.5920E-06 | 21 | 5.2210E-13 | 1.3090E-03 | 9.6552E+04 | 7.4900E+08 | 5.3640E+04 |
| 32.0 - 37.0 | 7.1200E+07 | 4.3580E-06 | 1311 | 3.8630E-06 | 5.9160E+02 | 8.5680E-07 | 20 | 8.2630E-14 | 5.0690E-04 | 3.6091E+04 | 1.4740E+08 | 2.3790E+04 |
| 37.0 - 42.0 | 6.9930E+07 | 4.3680E-06 | 274 | 4.1460E-06 | 5.9020E+02 | 1.9030E-07 | 20 | 1.1270E-14 | 1.1230E-04 | 7.8543E+03 | 1.9410E+07 | 8.6350E+03 |
| 42.0 - 47.0 | 6.9200E+07 | 7.2560E-06 | 195 | 1.5180E-05 | 3.5510E+02 | 6.6220E-08 | 20 | 3.3400E-15 | 2.3520E-05 | 1.6275E+03 | 2.0770E+06 | 2.8240E+03 |
| 47.0 - 52.0 | 6.8530E+07 | 5.2320E-06 | 440 | 5.4750E-06 | 4.9280E+02 | 9.0250E-08 | 19 | 4.1440E-15 | 4.4470E-05 | 3.0477E+03 | 4.7490E+06 | 4.2710E+03 |
| 52.0 - 57.0 | 6.7790E+07 | 5.2320E-06 | 440 | 5.4750E-06 | 4.9280E+02 | 3.1690E-07 | 19 | 4.5010E-14 | 1.5610E-04 | 1.0585E+04 | 5.0510E+07 | 1.3930E+04 |
| 57.0 - 62.0 | 6.7080E+07 | 5.2320E-06 | 440 | 5.4750E-06 | 4.9280E+02 | 2.3250E-07 | 19 | 1.4030E-14 | 1.1460E-04 | 7.6870E+03 | 1.5480E+07 | 7.7110E+03 |
| 62.0 - 67.0 | 6.6440E+07 | 5.2320E-06 | 440 | 5.4750E-06 | 4.9280E+02 | 1.9570E-07 | 19 | 6.5890E-15 | 9.6430E-05 | 6.4067E+03 | 7.1640E+06 | 5.2460E+03 |
| 67.0 - 72.0 | 6.5560E+07 | 5.2320E-06 | 440 | 5.4750E-06 | 4.9280E+02 | 3.2460E-07 | 18 | 1.9370E-14 | 1.6000E-04 | 1.0486E+04 | 2.0490E+07 | 8.8730E+03 |
| 72.0 - 77.0 | 6.3880E+07 | 5.2320E-06 | 440 | 5.4750E-06 | 4.9280E+02 | 1.7000E-06 | 18 | 2.1850E-12 | 8.3780E-04 | 5.3522E+04 | 2.1720E+09 | 9.1350E+04 |
| 77.0 - 82.0 | 6.2670E+07 | 5.2320E-06 | 440 | 5.4750E-06 | 4.9280E+02 | 1.5050E-06 | 18 | 2.0100E-12 | 7.4160E-04 | 4.6480E+04 | 1.9230E+09 | 8.5940E+04 |
| 82.0 - 87.0 | 6.0980E+07 | 5.2320E-06 | 440 | 5.4750E-06 | 4.9280E+02 | 1.6830E-08 | 18 | 1.5660E-16 | 8.2950E-06 | 5.0582E+02 | 1.4210E+05 | 7.3880E+02 |
| 87.0 - 92.0 | 5.9220E+07 | 5.2320E-06 | 440 | 5.4750E-06 | 4.9280E+02 | 5.3350E-09 | 17 | 1.2850E-17 | 2.6290E-06 | 1.5568E+02 | 1.1000E+04 | 2.0560E+02 |
| 92.0 - 97.0 | 5.8300E+07 | 5.2320E-06 | 440 | 5.4750E-06 | 4.9280E+02 | 8.2620E-10 | 17 | 6.8260E-19 | 4.0710E-07 | 2.3734E+01 | 5.6470E+02 | 4.6580E+01 |
| TOTAL | 1.5460E+09 | | | | | | | | | 8.6424E+06 | + DR - | 2.4010E+06 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 4.3030E+07.

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 8. Hydroacoustic estimate of fish inhabiting Area 2, Skilak Lake, Alaska based on Transect 4 integrator output.¹

| ² Depth Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Variance | Confidence Limits (95%) |
|---|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|------------|-------------------------------|
| 2.0 - 7.0 | 1.6710E+08 | 2.1850E-05 | 705 | 1.3100E-04 | 1.1800E+02 | 6.9740E-07 | 42 | 1.0340E-13 | 8.2290E-05 | 1.3751E+04 | 4.9840E+07 | 1.3840E+04 |
| 7.0 - 12.0 | 1.6650E+08 | 9.9770E-06 | 163 | 1.1770E-05 | 2.5840E+02 | 1.5710E-05 | 42 | 9.4200E-12 | 4.0610E-03 | 6.7609E+05 | 2.1340E+10 | 2.8630E+05 |
| 12.0 - 17.0 | 1.6480E+08 | 7.0430E-06 | 596 | 6.7630E-06 | 3.6610E+02 | 2.1930E-05 | 41 | 1.2220E-11 | 8.0270E-03 | 1.3228E+06 | 4.7180E+10 | 4.2570E+05 |
| 17.0 - 22.0 | 1.6220E+08 | 6.4760E-06 | 945 | 6.0930E-06 | 3.9810E+02 | 1.7450E-05 | 41 | 6.7500E-12 | 6.9480E-03 | 1.1270E+06 | 2.9340E+10 | 3.3570E+05 |
| 22.0 - 27.0 | 1.6070E+08 | 5.3250E-06 | 985 | 4.5850E-06 | 4.8420E+02 | 1.0640E-05 | 41 | 2.9650E-12 | 5.1520E-03 | 8.2806E+05 | 1.8470E+10 | 2.6640E+05 |
| 27.0 - 32.0 | 1.5960E+08 | 4.8320E-06 | 672 | 4.0300E-06 | 5.3360E+02 | 3.2150E-06 | 41 | 3.7680E-13 | 1.7150E-03 | 2.7382E+05 | 2.8120E+09 | 1.0390E+05 |
| 32.0 - 37.0 | 1.5870E+08 | 3.1990E-06 | 257 | 2.3040E-06 | 8.0590E+02 | 7.5520E-07 | 41 | 2.3460E-14 | 6.0870E-04 | 9.6581E+04 | 4.0260E+08 | 3.9320E+04 |
| 37.0 - 42.0 | 1.5760E+08 | 4.3680E-06 | 274 | 4.1460E-06 | 5.9020E+02 | 2.2560E-07 | 41 | 1.1500E-14 | 1.3320E-04 | 2.0985E+04 | 1.0100E+08 | 1.9700E+04 |
| 42.0 - 47.0 | 1.5650E+08 | 7.2600E-06 | 195 | 1.5180E-05 | 3.5510E+02 | 5.5600E-08 | 41 | 2.1410E-15 | 1.9740E-05 | 3.0893E+03 | 6.8240E+06 | 5.1200E+03 |
| 47.0 - 52.0 | 1.5540E+08 | 5.0600E-06 | 818 | 4.4110E-06 | 5.0950E+02 | 2.0350E-07 | 40 | 1.7690E-14 | 1.0370E-04 | 1.6117E+04 | 1.1120E+08 | 2.0670E+04 |
| 52.0 - 57.0 | 1.5440E+08 | 5.0600E-06 | 818 | 4.4110E-06 | 5.0950E+02 | 4.9610E-07 | 39 | 1.1070E-13 | 2.5280E-04 | 3.9024E+04 | 6.8640E+08 | 5.1350E+04 |
| 57.0 - 62.0 | 1.5170E+08 | 5.0600E-06 | 818 | 4.4110E-06 | 5.0950E+02 | 3.1430E-07 | 39 | 5.5870E-15 | 1.6010E-04 | 2.4298E+04 | 3.3950E+07 | 1.1420E+04 |
| 62.0 - 67.0 | 1.4370E+08 | 5.0600E-06 | 818 | 4.4110E-06 | 5.0950E+02 | 2.2940E-07 | 39 | 1.0360E-14 | 1.1690E-04 | 1.6794E+04 | 5.5800E+07 | 1.4640E+04 |
| 67.0 - 72.0 | 1.3760E+08 | 5.0600E-06 | 818 | 4.4110E-06 | 5.0950E+02 | 2.0070E-07 | 38 | 6.1610E-15 | 1.0230E-04 | 1.4074E+04 | 3.0480E+07 | 1.0820E+04 |
| 72.0 - 77.0 | 1.2970E+08 | 5.0600E-06 | 818 | 4.4110E-06 | 5.0950E+02 | 1.6090E-07 | 36 | 3.1880E-15 | 8.2000E-05 | 1.0638E+04 | 1.4030E+07 | 7.3420E+03 |
| 77.0 - 82.0 | 8.0520E+07 | 5.0600E-06 | 818 | 4.4110E-06 | 5.0950E+02 | 3.8080E-08 | 35 | 9.1260E-16 | 1.9410E-05 | 1.5625E+03 | 1.5380E+06 | 2.4310E+03 |
| 82.0 - 87.0 | 4.6630E+07 | 5.0600E-06 | 818 | 4.4110E-06 | 5.0950E+02 | 1.5180E-08 | 15 | 1.2960E-16 | 7.7360E-06 | 3.6072E+02 | 7.3280E+04 | 5.3060E+02 |
| 87.0 - 92.0 | 4.4490E+07 | 5.0600E-06 | 818 | 4.4110E-06 | 5.0950E+02 | 0.0000E+00 | 15 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 92.0 - 97.0 | 4.0680E+07 | 5.0600E-06 | 818 | 4.4110E-06 | 5.0950E+02 | 0.0000E+00 | 14 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 2.5385E+09 | | | | | | | | | 4.4850E+06 | + DR - | 6.8070E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 3.3460E+07

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 10. Hydroacoustic estimate of fish inhabiting Area 3, Skilak Lake, Alaska based on Transect 6 integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Variance | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|------------|-------------------------------|
| 2.0 - 7.0 | 1.1230E+08 | 2.1850E-05 | 705 | 1.3100E-04 | 1.1800E+02 | 0.0000E+00 | 28 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 7.0 - 12.0 | 1.1230E+08 | 1.1550E-05 | 2795 | 1.2280E-05 | 2.2320E+02 | 6.5080E-06 | 28 | 2.7580E-12 | 1.4530E-03 | 1.6320E+05 | 1.7450E+09 | 8.1880E+04 |
| 12.0 - 17.0 | 1.1220E+08 | 7.0470E-06 | 190 | 6.6370E-06 | 3.6590E+02 | 9.0490E-06 | 28 | 3.0810E-12 | 3.3110E-03 | 3.7147E+05 | 5.8360E+09 | 1.4970E+05 |
| 17.0 - 22.0 | 1.1150E+08 | 5.6810E-06 | 332 | 5.2860E-06 | 4.5380E+02 | 6.5300E-06 | 28 | 1.2740E-12 | 2.9640E-03 | 3.3038E+05 | 3.5450E+09 | 1.1670E+05 |
| 22.0 - 27.0 | 1.1090E+08 | 6.2210E-06 | 320 | 1.0970E-05 | 4.1440E+02 | 5.7590E-06 | 28 | 1.6500E-12 | 2.3870E-03 | 2.6460E+05 | 4.1640E+09 | 1.2650E+05 |
| 27.0 - 32.0 | 1.1050E+08 | 4.6430E-06 | 204 | 4.4400E-06 | 5.5530E+02 | 2.6260E-06 | 28 | 1.5620E-13 | 1.4580E-03 | 1.6111E+05 | 7.0420E+08 | 5.2010E+04 |
| 32.0 - 37.0 | 1.0970E+08 | 4.3580E-06 | 1311 | 3.8630E-06 | 5.9160E+02 | 7.0170E-07 | 28 | 2.0780E-14 | 4.1510E-04 | 4.5559E+04 | 1.2260E+08 | 2.1700E+04 |
| 37.0 - 42.0 | 1.0770E+08 | 4.3680E-06 | 274 | 4.1460E-06 | 5.9020E+02 | 2.6650E-07 | 28 | 2.2640E-14 | 1.5730E-04 | 1.6937E+04 | 9.2440E+07 | 1.8840E+04 |
| 42.0 - 47.0 | 1.0660E+08 | 7.2600E-06 | 195 | 1.5180E-05 | 3.5510E+02 | 3.1800E-07 | 27 | 3.0430E-14 | 1.1290E-04 | 1.2036E+04 | 4.6830E+07 | 1.3410E+04 |
| 47.0 - 52.0 | 1.0200E+08 | 6.9180E-06 | 892 | 8.5390E-06 | 3.7270E+02 | 1.6630E-07 | 27 | 5.2850E-15 | 6.2000E-05 | 6.3226E+03 | 7.7030E+06 | 5.4400E+03 |
| 52.0 - 57.0 | 9.8400E+07 | 6.9180E-06 | 892 | 8.5390E-06 | 3.7270E+02 | 5.8080E-07 | 26 | 3.7900E-14 | 2.1650E-04 | 2.1299E+04 | 5.1750E+07 | 1.4100E+04 |
| 57.0 - 62.0 | 9.7070E+07 | 6.9180E-06 | 892 | 8.5390E-06 | 3.7270E+02 | 9.5250E-07 | 25 | 7.8750E-14 | 3.5500E-04 | 3.4457E+04 | 1.0510E+08 | 2.0090E+04 |
| 62.0 - 67.0 | 9.5140E+07 | 6.9180E-06 | 892 | 8.5390E-06 | 3.7270E+02 | 1.5490E-06 | 25 | 1.8730E-13 | 5.7720E-04 | 5.4917E+04 | 2.4060E+08 | 3.0400E+04 |
| 67.0 - 72.0 | 9.3980E+07 | 6.9180E-06 | 892 | 8.5390E-06 | 3.7270E+02 | 7.1580E-07 | 25 | 4.7100E-14 | 2.6680E-04 | 2.5069E+04 | 5.8850E+07 | 1.5040E+04 |
| 72.0 - 77.0 | 8.8970E+07 | 6.9180E-06 | 892 | 8.5390E-06 | 3.7270E+02 | 8.8350E-07 | 25 | 2.0550E-13 | 3.2920E-04 | 2.9294E+04 | 2.2740E+08 | 2.9550E+04 |
| 77.0 - 82.0 | 8.5440E+07 | 6.9180E-06 | 892 | 8.5390E-06 | 3.7270E+02 | 3.3600E-07 | 25 | 1.8290E-14 | 1.2520E-04 | 1.0700E+04 | 1.8750E+07 | 8.4860E+03 |
| 82.0 - 87.0 | 8.2240E+07 | 6.9180E-06 | 892 | 8.5390E-06 | 3.7270E+02 | 3.3090E-07 | 25 | 4.6060E-14 | 1.2330E-04 | 1.0142E+04 | 4.3450E+07 | 1.2920E+04 |
| 87.0 - 92.0 | 7.6200E+07 | 6.9180E-06 | 892 | 8.5390E-06 | 3.7270E+02 | 5.2180E-07 | 24 | 3.9040E-14 | 1.9450E-04 | 1.4819E+04 | 3.1860E+07 | 1.1060E+04 |
| 92.0 - 97.0 | 6.7100E+07 | 6.9180E-06 | 892 | 8.5390E-06 | 3.7270E+02 | 4.7120E-07 | 22 | 4.4370E-14 | 1.7560E-04 | 1.1782E+04 | 2.7980E+07 | 1.0370E+04 |
| TOTAL | 1.8802E+09 | | | | | | | | | 1.5841E+06 | + DR - | 2.5610E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 2.2500E+07

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 12. Hydroacoustic estimate of fish inhabiting Area 1, Kenai Lake, Alaska based on Transect 7 (night survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|-------------------------------|
| 2.0 - 7.0 | 3.8580E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 1.3510E-05 | 19 | 3.8880E-11 | 3.3160E-03 | 1.2794E+05 | 3.5830E+09 |
| 7.0 - 12.0 | 3.8590E+07 | 1.1150E-05 | 1258 | 4.3390E-05 | 2.3120E+02 | 1.5810E-05 | 19 | 5.3530E-11 | 3.6560E-03 | 1.4109E+05 | 4.5030E+09 |
| 12.0 - 17.0 | 3.8590E+07 | 7.9780E-06 | 262 | 1.9390E-05 | 3.2320E+02 | 8.8440E-06 | 19 | 2.1390E-11 | 2.8580E-03 | 1.1031E+05 | 3.6020E+09 |
| 17.0 - 22.0 | 3.8290E+07 | 4.3720E-06 | 395 | 4.5970E-06 | 5.8970E+02 | 5.3390E-06 | 19 | 1.1470E-12 | 3.1480E-03 | 1.2055E+05 | 6.2570E+08 |
| 22.0 - 27.0 | 3.6950E+07 | 3.5280E-06 | 256 | 3.6210E-06 | 7.3080E+02 | 1.8460E-06 | 19 | 3.4000E-13 | 1.3490E-03 | 4.9843E+04 | 2.5810E+08 |
| 27.0 - 32.0 | 3.3580E+07 | 4.0000E-06 | 282 | 3.5180E-06 | 6.4460E+02 | 1.4730E-06 | 19 | 1.7680E-13 | 9.4920E-04 | 3.1874E+04 | 8.5620E+07 |
| 32.0 - 37.0 | 2.5570E+07 | 3.7240E-06 | 2695 | 3.8050E-06 | 6.9230E+02 | 1.6810E-07 | 16 | 1.9340E-14 | 1.1640E-04 | 2.9762E+03 | 6.0650E+06 |
| 37.0 - 42.0 | 9.4170E+06 | 3.4600E-06 | 1011 | 2.9980E-06 | 7.4510E+02 | 1.0590E-08 | 12 | 1.1220E-16 | 7.8940E-06 | 7.4335E+01 | 5.5300E+03 |
| 42.0 - 47.0 | 0.0000E+00 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 47.0 - 52.0 | 0.0000E+00 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 2.5957E+08 | | | | | | | | 5.8466E+05 | + DR - | 2.2060E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 7.7200E+06

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 14. Hydroacoustic estimate of fish inhabiting Area 1, Kenai Lake, Alaska based on Transect 9A (night survey) integrator output.¹

| ² Depth Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no. /m ³) | Estimated Number of Fish | Confidence Limits (95%) |
|---|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|---|--------------------------------|-------------------------------|
| 2.0 - 7.0 | 3.8510E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 1.0210E-05 | 23 | 3.4320E-11 | 2.5070E-03 | 9.6528E+04 | 3.1220E+09 1.0950E+05 |
| 7.0 - 12.0 | 3.8230E+07 | 1.1150E-05 | 1258 | 4.3390E-05 | 2.3120E+02 | 1.5830E-05 | 23 | 3.1390E-11 | 3.6590E-03 | 1.3989E+05 | 2.6880E+09 1.0160E+05 |
| 12.0 - 17.0 | 3.7170E+07 | 7.1520E-06 | 345 | 6.6730E-06 | 3.6050E+02 | 1.2760E-05 | 23 | 8.5030E-12 | 4.5990E-03 | 1.7092E+05 | 1.6000E+09 7.8410E+04 |
| 17.0 - 22.0 | 3.5380E+07 | 4.3100E-06 | 231 | 4.9430E-06 | 5.9820E+02 | 2.3450E-06 | 22 | 4.0700E-13 | 1.4020E-03 | 4.9615E+04 | 1.9630E+08 2.7460E+04 |
| 22.0 - 27.0 | 3.2080E+07 | 4.5690E-06 | 286 | 4.8830E-06 | 5.6430E+02 | 2.7050E-06 | 21 | 5.2710E-13 | 1.5260E-03 | 4.8959E+04 | 1.8230E+08 2.6460E+04 |
| 27.0 - 32.0 | 2.9000E+07 | 3.7150E-06 | 185 | 3.3550E-06 | 6.9400E+02 | 1.0040E-06 | 19 | 8.3460E-14 | 6.9670E-04 | 2.0204E+04 | 3.5610E+07 1.1700E+04 |
| 32.0 - 37.0 | 2.6260E+07 | 3.7240E-06 | 2695 | 3.8050E-06 | 6.9230E+02 | 4.2670E-07 | 18 | 3.0280E-14 | 2.9540E-04 | 7.7590E+03 | 1.0030E+07 6.2080E+03 |
| 37.0 - 42.0 | 2.3600E+07 | 3.4600E-06 | 1011 | 2.9980E-06 | 7.4510E+02 | 4.6640E-07 | 16 | 3.0800E-14 | 3.4750E-04 | 8.2016E+03 | 9.5740E+06 6.0640E+03 |
| 42.0 - 47.0 | 1.9690E+07 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 6.5250E-08 | 16 | 4.1730E-15 | 5.6640E-05 | 1.1154E+03 | 1.2220E+06 2.1670E+03 |
| 47.0 - 52.0 | 1.2820E+07 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 2.3830E-09 | 12 | 3.0030E-18 | 3.1200E-06 | 3.9996E+01 | 8.6430E+02 5.7620E+01 |
| TOTAL | 2.9274E+08 | | | | | | | | 5.4323E+05 | + OR - | 1.7360E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 7.7200E+06

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 16. Hydroacoustic estimate of fish inhabiting Area 2, Kenai Lake, Alaska based on Transect 10A (night survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|------------|-------------------------------|
| | | | | | | | | | | Fish Variance | Variance | |
| 2.0 - 7.0 | 5.9530E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 1.0320E-05 | 22 | 1.8890E-11 | 2.5340E-03 | 1.5084E+05 | 4.1660E+09 | 1.2650E+05 |
| 7.0 - 12.0 | 5.9540E+07 | 6.9020E-06 | 165 | 7.9920E-06 | 3.7350E+02 | 1.4900E-05 | 22 | 6.4940E-12 | 5.5680E-03 | 3.3147E+05 | 4.1050E+09 | 1.2560E+05 |
| 12.0 - 17.0 | 5.9390E+07 | 5.8930E-06 | 519 | 6.4230E-06 | 4.3750E+02 | 2.0520E-05 | 22 | 1.7750E-11 | 8.9800E-03 | 5.3331E+05 | 1.2640E+10 | 2.2030E+05 |
| 17.0 - 22.0 | 5.9180E+07 | 5.3370E-06 | 480 | 5.0280E-06 | 4.8310E+02 | 1.2710E-05 | 22 | 6.5080E-12 | 6.1420E-03 | 3.6348E+05 | 5.5630E+09 | 1.4620E+05 |
| 22.0 - 27.0 | 5.8930E+07 | 4.8860E-06 | 837 | 4.6760E-06 | 5.2770E+02 | 1.2370E-05 | 22 | 8.6650E-12 | 6.5300E-03 | 3.8481E+05 | 8.5410E+09 | 1.8110E+05 |
| 27.0 - 32.0 | 5.8690E+07 | 4.2590E-06 | 514 | 3.8720E-06 | 6.0540E+02 | 3.3450E-06 | 21 | 4.2680E-13 | 2.0250E-03 | 1.1882E+05 | 5.6140E+08 | 4.6440E+04 |
| 32.0 - 37.0 | 5.8420E+07 | 3.7910E-06 | 421 | 3.7090E-06 | 6.8010E+02 | 1.9350E-06 | 21 | 3.0290E-13 | 1.3160E-03 | 7.6866E+04 | 4.9170E+08 | 4.3460E+04 |
| 37.0 - 42.0 | 5.8230E+07 | 3.4600E-06 | 1011 | 2.9980E-06 | 7.4510E+02 | 1.4800E-07 | 21 | 3.6600E-15 | 1.1030E-04 | 6.4208E+03 | 6.9210E+06 | 5.1560E+03 |
| 42.0 - 47.0 | 5.8130E+07 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 1.0960E-07 | 21 | 5.8630E-15 | 9.5130E-05 | 5.5297E+03 | 1.5010E+07 | 7.5930E+03 |
| 47.0 - 52.0 | 5.7840E+07 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 2.0280E-08 | 21 | 4.1110E-16 | 2.6550E-05 | 1.5357E+03 | 2.3850E+06 | 3.0270E+03 |
| TOTAL | 5.8788E+08 | | | | | | | | | 1.9731E+06 | + DR - | 3.7230E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.1910E+07

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 1B. Hydroacoustic estimate of fish inhabiting Area 2, Kenai Lake, Alaska based on Transect 11A (night survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|-------------------------------|
| 2.0 - 7.0 | 5.9240E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 8.8380E-07 | 26 | 2.9800E-13 | 2.1700E-04 | 1.2856E+04 | 6.3990E+07 |
| 7.0 - 12.0 | 5.9100E+07 | 1.1150E-05 | 1258 | 4.3390E-05 | 2.3120E+02 | 1.1890E-05 | 26 | 8.8820E-12 | 2.7490E-03 | 1.6245E+05 | 1.9760E+09 |
| 12.0 - 17.0 | 5.8930E+07 | 6.1810E-06 | 304 | 6.1560E-06 | 4.1710E+02 | 1.1280E-05 | 26 | 5.4780E-12 | 4.7070E-03 | 2.7738E+05 | 3.5610E+09 |
| 17.0 - 22.0 | 5.8780E+07 | 4.4710E-06 | 459 | 5.3620E-06 | 5.7670E+02 | 7.1550E-06 | 25 | 2.0600E-12 | 4.1260E-03 | 2.4253E+05 | 2.5510E+09 |
| 22.0 - 27.0 | 5.8570E+07 | 4.5810E-06 | 270 | 3.9830E-06 | 5.6280E+02 | 3.0070E-06 | 25 | 1.2380E-12 | 1.6920E-03 | 9.9127E+04 | 1.3730E+09 |
| 27.0 - 32.0 | 5.8370E+07 | 4.2650E-06 | 210 | 3.3310E-06 | 6.0450E+02 | 1.4470E-06 | 25 | 2.0210E-13 | 8.7480E-04 | 5.1068E+04 | 2.5920E+08 |
| 32.0 - 37.0 | 5.8180E+07 | 4.1290E-06 | 282 | 3.9290E-06 | 6.2440E+02 | 1.5900E-06 | 25 | 3.9770E-13 | 9.9270E-04 | 5.7761E+04 | 5.3570E+08 |
| 37.0 - 42.0 | 5.7990E+07 | 3.4600E-06 | 1011 | 2.9980E-06 | 7.4510E+02 | 2.6190E-07 | 25 | 9.6110E-15 | 1.9520E-04 | 1.1318E+04 | 1.8040E+07 |
| 42.0 - 47.0 | 5.7790E+07 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 1.4970E-10 | 25 | 2.2420E-20 | 1.3000E-07 | 7.5123E+00 | 5.6580E+01 |
| 47.0 - 52.0 | 3.4440E+07 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 1.0880E-09 | 25 | 1.1840E-18 | 1.4250E-06 | 4.9067E+01 | 2.4350E+03 |
| TOTAL | 5.6139E+08 | | | | | | | | 9.1455E+05 | + DR - | 1.9930E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.1910E+07

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 20. Hydroacoustic estimate of fish inhabiting Area 3, Kenai Lake, Alaska based on Transect 12A (night survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean | Number | Standard | A | Integrator Output | Number of Sequences | Mean | Fish | Estimated | Confidence Limits (95%) | |
|--------------------------------------|--|------------|----------------|--------------------|------------|----------------------|---------------------------|------------|----------------------------------|-------------------|-------------------------------|------------|
| | | Sigma | Echoes Used | Deviation Sigma | | | | Variance | Density (no./m ³) | Number of Fish | | |
| 2.0 - 7.0 | 5.2650E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 8.7800E-07 | 28 | 6.6030E-13 | 2.1560E-04 | 1.1351E+04 | 1.1110E+08 | 2.0660E+04 |
| 7.0 - 12.0 | 5.2350E+07 | 1.1150E-05 | 1258 | 4.3390E-05 | 2.3120E+02 | 5.9780E-06 | 28 | 4.9460E-12 | 1.3820E-03 | 7.2363E+04 | 7.8770E+08 | 5.5010E+04 |
| 12.0 - 17.0 | 5.1790E+07 | 6.6990E-06 | 178 | 7.0620E-06 | 3.8490E+02 | 6.2940E-06 | 28 | 1.6930E-12 | 2.4220E-03 | 1.2547E+05 | 7.7100E+08 | 5.4420E+04 |
| 17.0 - 22.0 | 5.0930E+07 | 4.7390E-06 | 275 | 5.2820E-06 | 5.4400E+02 | 4.0640E-06 | 28 | 5.2640E-13 | 2.2110E-03 | 1.1259E+05 | 4.6140E+08 | 4.2100E+04 |
| 22.0 - 27.0 | 4.9310E+07 | 4.3610E-06 | 264 | 3.8150E-06 | 5.9120E+02 | 2.4330E-06 | 28 | 2.9020E-13 | 1.4380E-03 | 7.0920E+04 | 2.6120E+08 | 3.1680E+04 |
| 27.0 - 32.0 | 4.8190E+07 | 4.5640E-06 | 308 | 3.6840E-06 | 5.6490E+02 | 1.8020E-06 | 28 | 2.0500E-13 | 1.0180E-03 | 4.9063E+04 | 1.5700E+08 | 2.4560E+04 |
| 32.0 - 37.0 | 4.7340E+07 | 4.3990E-06 | 190 | 2.9150E-06 | 5.8610E+02 | 6.0760E-07 | 27 | 2.6750E-14 | 3.5610E-04 | 1.6860E+04 | 2.1250E+07 | 9.0350E+03 |
| 37.0 - 42.0 | 4.6280E+07 | 3.4600E-06 | 1011 | 2.9980E-06 | 7.4510E+02 | 6.1010E-08 | 27 | 5.9220E-16 | 4.5460E-05 | 2.1037E+03 | 7.0740E+05 | 1.6490E+03 |
| 42.0 - 47.0 | 4.2870E+07 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 1.5370E-08 | 26 | 1.2860E-16 | 1.3340E-05 | 5.7211E+02 | 1.7890E+05 | 8.2910E+02 |
| 47.0 - 52.0 | 3.8540E+07 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 0.0000E+00 | 25 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 4.8025E+08 | | | | | | | | 4.6129E+05 | + DR - | 9.9390E+04 | |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.0540E+07.

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 22. Hydroacoustic estimate of fish inhabiting Area 3, Kenai Lake, Alaska based on Transect 13A (night survey) integrator output.¹

| ² Depth Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Confidence Limits (95%) |
|---|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|-------------------------------|
| 2.0 - 7.0 | 5.2660E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 2.7470E-06 | 21 | 1.8460E-12 | 6.7450E-04 | 3.5518E+04 | 3.1590E+08 |
| 7.0 - 12.0 | 5.2680E+07 | 1.1150E-05 | 1258 | 4.3390E-05 | 2.3120E+02 | 5.8030E-06 | 21 | 3.0890E-12 | 1.3420E-03 | 7.0680E+04 | 5.1850E+08 |
| 12.0 - 17.0 | 5.2680E+07 | 6.4760E-06 | 3306 | 8.4200E-06 | 3.9810E+02 | 5.2260E-06 | 21 | 3.1950E-12 | 2.0810E-03 | 1.0950E+05 | 1.4110E+09 |
| 17.0 - 22.0 | 5.2660E+07 | 6.1620E-06 | 188 | 5.9770E-06 | 4.1840E+02 | 5.6760E-06 | 21 | 6.4720E-12 | 2.3750E-03 | 1.2508E+05 | 3.2210E+09 |
| 22.0 - 27.0 | 5.2420E+07 | 6.1940E-06 | 164 | 5.0470E-06 | 4.1620E+02 | 2.1230E-06 | 21 | 3.9920E-13 | 8.8360E-04 | 4.6313E+04 | 1.9870E+08 |
| 27.0 - 32.0 | 5.1490E+07 | 3.8570E-06 | 201 | 3.0930E-06 | 6.6840E+02 | 2.1090E-06 | 21 | 4.0310E-13 | 1.4090E-03 | 7.2575E+04 | 4.9440E+08 |
| 32.0 - 37.0 | 5.0160E+07 | 3.7240E-06 | 2695 | 3.8050E-06 | 6.9230E+02 | 7.9300E-07 | 21 | 4.3270E-14 | 5.4900E-04 | 2.7537E+04 | 5.2470E+07 |
| 37.0 - 42.0 | 4.9520E+07 | 3.4600E-06 | 1011 | 2.9980E-06 | 7.4510E+02 | 2.8130E-07 | 20 | 1.6100E-14 | 2.0960E-04 | 1.0381E+04 | 2.2000E+07 |
| 42.0 - 47.0 | 4.8780E+07 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 3.2650E-08 | 20 | 5.3290E-16 | 2.8340E-05 | 1.3825E+03 | 9.6050E+05 |
| 47.0 - 52.0 | 4.8220E+07 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 0.0000E+00 | 20 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 5.1127E+08 | | | | | | | | 4.9907E+05 | + OR - | 1.5480E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.0540E+07

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 24. Hydroacoustic estimate of fish inhabiting Area 4, Kenai Lake, Alaska based on Transect 14A (night survey) integrator output.¹

| Depth Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | | Confidence Limits (95%) |
|-------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|------------|-------------------------------|
| | | | | | | | | | | Fish Variance | Variance | |
| 2.0 - 7.0 | 7.1790E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 1.5800E-06 | 24 | 1.5470E-12 | 3.8800E-04 | 2.7852E+04 | 4.8500E+08 | 4.3160E+04 |
| 7.0 - 12.0 | 7.1590E+07 | 1.1150E-05 | 1258 | 4.3390E-05 | 2.3120E+02 | 7.4360E-06 | 24 | 1.3030E-11 | 1.7190E-03 | 1.2309E+05 | 3.7530E+09 | 1.2010E+05 |
| 12.0 - 17.0 | 7.1190E+07 | 6.4760E-06 | 3306 | 8.4200E-06 | 3.9810E+02 | 9.0010E-06 | 24 | 4.4700E-12 | 3.5830E-03 | 2.5511E+05 | 3.6240E+09 | 1.1800E+05 |
| 17.0 - 22.0 | 7.0930E+07 | 5.7720E-06 | 299 | 6.0400E-06 | 4.4670E+02 | 4.7310E-06 | 24 | 1.4120E-12 | 2.1130E-03 | 1.4991E+05 | 1.5000E+09 | 7.5920E+04 |
| 22.0 - 27.0 | 7.0780E+07 | 4.9470E-06 | 444 | 4.0820E-06 | 5.2120E+02 | 8.0320E-06 | 24 | 4.9850E-12 | 4.1860E-03 | 2.9626E+05 | 6.9180E+09 | 1.6300E+05 |
| 27.0 - 32.0 | 7.0620E+07 | 3.8320E-06 | 510 | 3.4800E-06 | 6.7280E+02 | 9.7190E-06 | 23 | 1.8380E-11 | 6.5390E-03 | 4.6179E+05 | 4.1850E+10 | 4.0100E+05 |
| 32.0 - 37.0 | 7.0450E+07 | 3.4450E-06 | 625 | 2.9490E-06 | 7.4840E+02 | 2.8680E-06 | 23 | 1.4060E-13 | 2.1460E-03 | 1.5119E+05 | 4.1760E+08 | 4.0050E+04 |
| 37.0 - 42.0 | 7.0260E+07 | 3.5500E-06 | 219 | 3.0050E-06 | 7.2630E+02 | 6.8060E-07 | 23 | 2.1250E-14 | 4.9430E-04 | 3.4727E+04 | 5.9260E+07 | 1.5090E+04 |
| 42.0 - 47.0 | 6.9960E+07 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 1.0840E-07 | 23 | 2.4340E-15 | 9.4140E-05 | 6.5862E+03 | 9.0880E+06 | 5.9090E+03 |
| 47.0 - 52.0 | 3.8830E+07 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 1.1370E-09 | 23 | 1.2930E-18 | 1.4890E-06 | 5.7819E+01 | 3.3810E+03 | 1.1400E+02 |
| TOTAL | 6.7640E+08 | | | | | | | | | 1.5066E+06 | + DR - | 4.7450E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.4370E+07.

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 26. Hydroacoustic estimate of fish inhabiting Area 4, Kenai Lake, Alaska based on Transect 15A (night survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|-------------------------------|
| 2.0 - 7.0 | 7.1810E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 0.0000E+00 | 27 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 7.0 - 12.0 | 7.1690E+07 | 1.1150E-05 | 1258 | 4.3390E-05 | 2.3120E+02 | 1.3140E-06 | 27 | 6.0290E-13 | 3.0390E-04 | 2.1784E+04 | 1.7140E+08 |
| 12.0 - 17.0 | 7.1590E+07 | 6.4760E-06 | 3306 | 8.4200E-06 | 3.9810E+02 | 1.7380E-06 | 27 | 1.1910E-12 | 6.9190E-04 | 4.9531E+04 | 9.6890E+08 |
| 17.0 - 22.0 | 7.1450E+07 | 5.2610E-06 | 4648 | 5.9940E-06 | 4.9010E+02 | 1.4240E-06 | 27 | 4.1200E-13 | 6.9780E-04 | 4.9856E+04 | 5.0590E+08 |
| 22.0 - 27.0 | 7.1290E+07 | 4.4860E-06 | 4383 | 4.2580E-06 | 5.7470E+02 | 8.2900E-07 | 27 | 6.2060E-14 | 4.7650E-04 | 3.3968E+04 | 1.0440E+08 |
| 27.0 - 32.0 | 7.1100E+07 | 4.1000E-06 | 3789 | 3.5950E-06 | 6.2880E+02 | 4.9920E-07 | 27 | 2.7370E-14 | 3.1390E-04 | 2.2320E+04 | 5.4820E+07 |
| 32.0 - 37.0 | 7.0720E+07 | 3.7240E-06 | 2695 | 3.8050E-06 | 6.9230E+02 | 7.2060E-08 | 26 | 2.0110E-15 | 4.9890E-05 | 3.5284E+03 | 4.8270E+06 |
| 37.0 - 42.0 | 7.0460E+07 | 3.4600E-06 | 1011 | 2.9980E-06 | 7.4510E+02 | 3.9830E-08 | 26 | 6.3840E-16 | 2.9680E-05 | 2.0911E+03 | 1.7630E+06 |
| 42.0 - 47.0 | 7.0230E+07 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 1.8190E-08 | 26 | 3.3080E-16 | 1.5790E-05 | 1.1089E+03 | 1.2330E+06 |
| 47.0 - 52.0 | 4.7530E+07 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 0.0000E+00 | 26 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 6.8787E+08 | | | | | | | | 1.8419E+05 | + DR - | 8.3460E+04 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.4370E+07

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 28. Hydroacoustic estimate of fish inhabiting Area 5, Kenai Lake, Alaska based on Transect 16A (night survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Estimated Variance | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|-----------------------|-------------------------------|
| 2.0 - 7.0 | 5.4620E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 5.6240E-06 | 33 | 4.1750E-12 | 1.3810E-03 | 7.5426E+04 | 7.8370E+08 | 5.4870E+04 |
| 7.0 - 12.0 | 5.4640E+07 | 1.1150E-05 | 1258 | 4.3390E-05 | 2.3120E+02 | 2.0970E-06 | 33 | 8.4060E-13 | 4.8480E-04 | 2.6488E+04 | 1.4260E+08 | 2.3410E+04 |
| 12.0 - 17.0 | 5.2220E+07 | 6.4760E-06 | 3306 | 8.4200E-06 | 3.9810E+02 | 1.0450E-06 | 33 | 1.8830E-13 | 4.1590E-04 | 2.1718E+04 | 8.1630E+07 | 1.7710E+04 |
| 17.0 - 22.0 | 5.0320E+07 | 5.2610E-06 | 4648 | 5.9940E-06 | 4.9010E+02 | 2.0510E-06 | 32 | 5.7470E-13 | 1.0050E-03 | 5.0576E+04 | 3.5020E+08 | 3.6680E+04 |
| 22.0 - 27.0 | 4.9390E+07 | 4.4860E-06 | 4383 | 4.2580E-06 | 5.7470E+02 | 5.8170E-07 | 32 | 4.5720E-14 | 3.3430E-04 | 1.6510E+04 | 3.6890E+07 | 1.1900E+04 |
| 27.0 - 32.0 | 4.7680E+07 | 4.1000E-06 | 3789 | 3.5950E-06 | 6.2880E+02 | 5.6710E-07 | 31 | 7.5660E-14 | 3.5660E-04 | 1.7004E+04 | 6.8070E+07 | 1.6170E+04 |
| 32.0 - 37.0 | 4.6620E+07 | 3.7240E-06 | 2695 | 3.8050E-06 | 6.9230E+02 | 1.0960E-07 | 30 | 2.9510E-15 | 7.5860E-05 | 3.5361E+03 | 3.0780E+06 | 3.4390E+03 |
| 37.0 - 42.0 | 4.5680E+07 | 3.4600E-06 | 1011 | 2.9980E-06 | 7.4510E+02 | 3.2770E-09 | 30 | 1.0740E-17 | 2.4420E-06 | 1.1156E+02 | 1.2450E+04 | 2.1870E+02 |
| 42.0 - 47.0 | 4.4170E+07 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 0.0000E+00 | 29 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 47.0 - 52.0 | 3.0800E+07 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 2.5850E-10 | 29 | 6.6830E-20 | 3.3850E-07 | 1.0424E+01 | 1.0990E+02 | 2.0550E+01 |
| TOTAL | 4.7614E+08 | | | | | | | | 2.1138E+05 | + DR - | | 7.5050E+04 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.0930E+07.

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 30. Hydroacoustic estimate of fish inhabiting Area 5, Kenai Lake, Alaska based on Transect 17 (night survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|------------|-------------------------------|
| | | | | | | | | | | Fish Variance | Variance | |
| 2.0 - 7.0 | 5.4630E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 3.3540E-07 | 11 | 7.1010E-14 | 8.2340E-05 | 4.4983E+03 | 1.2890E+07 | 7.0380E+03 |
| 7.0 - 12.0 | 5.4650E+07 | 1.1150E-05 | 1258 | 4.3390E-05 | 2.3120E+02 | 6.6120E-07 | 11 | 3.3770E-13 | 1.5290E-04 | 8.3554E+03 | 5.4770E+07 | 1.4510E+04 |
| 12.0 - 17.0 | 5.4650E+07 | 6.4760E-06 | 3306 | 8.4200E-06 | 3.9810E+02 | 2.5620E-07 | 11 | 2.5560E-14 | 1.0200E-04 | 5.5746E+03 | 1.2120E+07 | 6.8230E+03 |
| 17.0 - 22.0 | 5.4650E+07 | 5.2610E-06 | 4648 | 5.9940E-06 | 4.9010E+02 | 4.1920E-07 | 11 | 7.1180E-14 | 2.0540E-04 | 1.1226E+04 | 5.1090E+07 | 1.4010E+04 |
| 22.0 - 27.0 | 5.4650E+07 | 4.4860E-06 | 4383 | 4.2580E-06 | 5.7470E+02 | 4.7300E-08 | 11 | 2.2370E-15 | 2.7180E-05 | 1.4856E+03 | 2.2070E+06 | 2.9120E+03 |
| 27.0 - 32.0 | 5.4650E+07 | 4.1000E-06 | 3789 | 3.5950E-06 | 6.2880E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 32.0 - 37.0 | 5.4650E+07 | 3.7240E-06 | 2695 | 3.8050E-06 | 6.9230E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 37.0 - 42.0 | 5.4650E+07 | 3.4600E-06 | 1011 | 2.9980E-06 | 7.4510E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 42.0 - 47.0 | 5.4650E+07 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 47.0 - 52.0 | 5.4650E+07 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 5.4648E+08 | | | | | | | | 3.1140E+04 | + OR - | 2.2610E+04 | |

² Lake surface area (meters squared) used to calculate stratum volume was 1.0930E+07.

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 32. Hydroacoustic estimate of fish inhabiting Area 5, Kenai Lake, Alaska based on Transect 19 (night survey) integrator output.¹

| ² Depth Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Variance | Confidence Limits (95%) |
|---|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|------------|-------------------------------|
| 2.0 - 7.0 | 5.4540E+07 | 1.0500E-05 | 177 | 1.0610E-05 | 2.4550E+02 | 1.7290E-06 | 10 | 1.2920E-12 | 4.2450E-04 | 2.3154E+04 | 2.3490E+08 | 3.0040E+04 |
| 7.0 - 12.0 | 5.4130E+07 | 1.1150E-05 | 1258 | 4.3390E-05 | 2.3120E+02 | 1.6340E-06 | 10 | 9.6900E-13 | 3.7790E-04 | 2.0457E+04 | 1.5690E+08 | 2.4550E+04 |
| 12.0 - 17.0 | 5.3610E+07 | 6.4760E-06 | 3306 | 8.4200E-06 | 3.9810E+02 | 2.3750E-06 | 10 | 2.4630E-12 | 9.4540E-04 | 5.0683E+04 | 1.1230E+09 | 6.5690E+04 |
| 17.0 - 22.0 | 5.3140E+07 | 5.2610E-06 | 4648 | 5.9940E-06 | 4.9010E+02 | 1.0180E-06 | 10 | 2.2330E-13 | 4.9880E-04 | 2.6504E+04 | 1.5160E+08 | 2.4140E+04 |
| 22.0 - 27.0 | 5.2090E+07 | 4.4860E-06 | 4383 | 4.2580E-06 | 5.7470E+02 | 1.2800E-07 | 10 | 1.1720E-14 | 7.3580E-05 | 3.8327E+03 | 1.0510E+07 | 6.3530E+03 |
| 27.0 - 32.0 | 4.8250E+07 | 4.1000E-06 | 3789 | 3.5950E-06 | 6.2880E+02 | 7.8020E-08 | 10 | 2.8070E-15 | 4.9060E-05 | 2.3672E+03 | 2.5850E+06 | 3.1510E+03 |
| 32.0 - 37.0 | 3.3800E+07 | 3.7240E-06 | 2695 | 3.8050E-06 | 6.9230E+02 | 0.0000E+00 | 10 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 37.0 - 42.0 | 2.2310E+07 | 3.4600E-06 | 1011 | 2.9980E-06 | 7.4510E+02 | 2.3270E-07 | 6 | 5.4130E-14 | 1.7340E-04 | 3.8685E+03 | 1.4980E+07 | 7.5850E+03 |
| 42.0 - 47.0 | 5.1060E+06 | 2.9700E-06 | 195 | 2.0890E-06 | 8.6810E+02 | 0.0000E+00 | 4 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 47.0 - 52.0 | 0.0000E+00 | 1.9690E-06 | 57 | 1.5930E-06 | 1.3090E+03 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 3.7698E+08 | | | | | | | | 1.3087E+05 | + DR - | 8.0690E+04 | |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.0930E+07

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 33, continued. Hydroacoustic estimate of the number of fish per 1000 square meters in Skilak Lake, October, 1986.

| Transect Number | Sequence Group | Sequence Number | Integrator Output | | | | A Constant | Density Estimate and 95% Confidence Interval | | | |
|--------------------|-------------------|--------------------|-------------------|------------|----------------|-----------------------|---------------|---|-----------------------|----------------|----------------|
| | | | Mean Output | Variance | Sample Size | Standard Deviation | | Mean Density | Standard Deviation | Lower Bound | Upper Bound |
| 4 | 1 | 1-5 | 8.0680E-05 | 3.0000E-09 | 5 | 5.4772E-05 | 4.525E+02 | 37 | 25 | -13 | 86 |
| | 2 | 6-10 | 1.1210E-04 | 4.0690E-09 | 5 | 6.3789E-05 | 4.525E+02 | 51 | 29 | -7 | 108 |
| | 3 | 11-15 | 1.2660E-04 | 5.9830E-09 | 5 | 7.7350E-05 | 4.525E+02 | 57 | 35 | -13 | 127 |
| | 4 | 16-20 | 2.0750E-04 | 1.2620E-08 | 5 | 1.1234E-04 | 4.525E+02 | 94 | 51 | -8 | 196 |
| | 5 | 21-25 | 3.1580E-04 | 6.1860E-08 | 5 | 2.4872E-04 | 4.525E+02 | 143 | 113 | -82 | 368 |
| | 6 | 26-30 | 4.6180E-04 | 1.9520E-08 | 5 | 1.3971E-04 | 4.525E+02 | 209 | 63 | 83 | 335 |
| | 7 | 31-35 | 7.2370E-04 | 4.3640E-08 | 5 | 2.0890E-04 | 4.525E+02 | 327 | 95 | 138 | 517 |
| | 8 | 36-40 | 5.5170E-04 | 2.7530E-08 | 5 | 1.6592E-04 | 4.525E+02 | 250 | 75 | 99 | 400 |
| | 9 | 41-42 | 7.8450E-04 | 1.1460E-06 | 2 | 1.0705E-03 | 4.525E+02 | 355 | 484 | -614 | 1324 |
| 5 | 1 | 26-28 | 3.4330E-04 | 5.8620E-08 | 3 | 2.4212E-04 | 4.740E+02 | 163 | 115 | -67 | 392 |
| | 2 | 21-25 | 1.6020E-04 | 5.0820E-09 | 5 | 7.1288E-05 | 4.740E+02 | 76 | 34 | 8 | 144 |
| | 3 | 16-20 | 2.4710E-04 | 1.4960E-08 | 5 | 1.2231E-04 | 4.740E+02 | 117 | 58 | 1 | 233 |
| | 4 | 11-15 | 3.2290E-04 | 3.6080E-08 | 5 | 1.8995E-04 | 4.740E+02 | 153 | 90 | -27 | 333 |
| | 5 | 6-10 | 1.8180E-04 | 2.6880E-09 | 5 | 5.1846E-05 | 4.740E+02 | 86 | 25 | 37 | 135 |
| | 6 | 1-5 | 1.3210E-04 | 8.8150E-09 | 5 | 9.3888E-05 | 4.740E+02 | 63 | 45 | -26 | 152 |
| 6 | 1 | 1-5 | 1.4830E-04 | 4.3070E-09 | 5 | 6.5628E-05 | 3.941E+02 | 58 | 26 | 7 | 110 |
| | 2 | 6-10 | 1.8080E-04 | 7.5800E-09 | 5 | 8.7063E-05 | 3.941E+02 | 71 | 34 | 3 | 140 |
| | 3 | 11-15 | 1.6280E-04 | 1.9480E-08 | 5 | 1.3957E-04 | 3.941E+02 | 64 | 55 | -46 | 174 |
| | 4 | 16-20 | 1.9730E-04 | 1.0330E-08 | 5 | 1.0164E-04 | 3.941E+02 | 78 | 40 | -2 | 158 |
| | 5 | 21-25 | 2.4170E-04 | 1.5530E-09 | 5 | 3.9408E-05 | 3.941E+02 | 95 | 16 | 64 | 126 |
| | 6 | 26-28 | 1.8760E-04 | 4.0740E-08 | 3 | 2.0184E-04 | 3.941E+02 | 74 | 80 | -85 | 233 |

Appendix Table 34, continued. Hydroacoustic estimate of the number of fish per 1000 square meters in Kenai Lake,
September, 1986.

| Transect Number | Sequence Group | Sequence Number | Integrator Output | | | | A Constant | Density Estimate and 95% Confidence Interval | | | |
|--------------------|-------------------|--------------------|-------------------|------------|----------------|-----------------------|---------------|---|-----------------------|----------------|----------------|
| | | | Mean Output | Variance | Sample Size | Standard Deviation | | Mean Density | Standard Deviation | Lower Bound | Upper Bound |
| 13A | 1 | 16-21 | 1.5090E-04 | 1.7405E-08 | 6 | 1.3193E-04 | 5.047E+02 | 76 | 67 | -57 | 209 |
| | 2 | 11-15 | 1.2300E-04 | 8.6556E-09 | 5 | 9.3035E-05 | 5.047E+02 | 62 | 47 | -32 | 156 |
| | 3 | 6-10 | 7.9751E-05 | 2.0611E-09 | 5 | 4.5399E-05 | 5.047E+02 | 40 | 23 | -6 | 86 |
| | 4 | 1-5 | 1.2328E-04 | 1.6743E-08 | 5 | 1.2939E-04 | 5.047E+02 | 62 | 65 | -68 | 193 |
| 12 | 1 | 1-5 | 1.1166E-04 | 1.0341E-08 | 5 | 1.0169E-04 | 5.294E+02 | 59 | 54 | -49 | 167 |
| | 2 | 6-10 | 1.7105E-04 | 3.7209E-09 | 5 | 6.0999E-05 | 5.294E+02 | 91 | 32 | 26 | 155 |
| | 3 | 11-15 | 9.1493E-05 | 8.7173E-09 | 5 | 9.3366E-05 | 5.294E+02 | 48 | 49 | -50 | 147 |
| 12A | 1 | 26-28 | 7.9238E-05 | 4.7921E-09 | 3 | 6.9225E-05 | 5.221E+02 | 41 | 36 | -31 | 114 |
| | 2 | 21-25 | 7.4502E-05 | 2.6294E-09 | 5 | 5.1278E-05 | 5.221E+02 | 39 | 27 | -15 | 92 |
| | 3 | 16-20 | 1.0360E-04 | 4.7451E-09 | 5 | 6.8885E-05 | 5.221E+02 | 54 | 36 | -18 | 126 |
| | 4 | 11-15 | 7.6933E-05 | 1.7995E-09 | 5 | 4.2421E-05 | 5.221E+02 | 40 | 22 | -4 | 84 |
| | 5 | 6-10 | 1.1252E-04 | 3.2386E-09 | 5 | 5.6909E-05 | 5.221E+02 | 59 | 30 | -1 | 118 |
| | 6 | 1-5 | 2.0592E-04 | 3.1732E-08 | 5 | 1.7813E-04 | 5.221E+02 | 108 | 93 | -78 | 294 |
| 11 | 1 | 1-5 | 1.0605E-04 | 4.9437E-09 | 5 | 7.0311E-05 | 5.947E+02 | 63 | 42 | -21 | 147 |
| | 2 | 6-10 | 6.3564E-05 | 7.2822E-10 | 5 | 2.6986E-05 | 5.947E+02 | 38 | 16 | 6 | 70 |
| | 3 | 11-12 | 7.0822E-05 | 6.0783E-10 | 2 | 2.4654E-05 | 5.947E+02 | 42 | 15 | 13 | 71 |
| 11A | 1 | 21-25 | 4.5493E-04 | 1.9967E-08 | 5 | 1.4130E-04 | 5.172E+02 | 235 | 73 | 89 | 381 |
| | 2 | 16-20 | 7.7324E-05 | 4.2253E-09 | 5 | 6.5002E-05 | 5.172E+02 | 40 | 34 | -27 | 107 |
| | 3 | 11-15 | 1.8621E-04 | 3.0183E-09 | 5 | 5.4939E-05 | 5.172E+02 | 96 | 28 | 39 | 153 |
| | 4 | 6-10 | 1.7539E-04 | 1.4977E-08 | 5 | 1.2238E-04 | 5.172E+02 | 91 | 63 | -36 | 217 |
| | 5 | 1-5 | 4.6788E-05 | 1.3249E-08 | 5 | 1.1510E-04 | 5.172E+02 | 24 | 60 | -95 | 143 |
| 10 | 1 | 1-5 | 2.8512E-04 | 9.3777E-09 | 5 | 9.6839E-05 | 5.123E+02 | 146 | 50 | 47 | 245 |
| | 2 | 6-10 | 8.4697E-04 | 4.8935E-08 | 5 | 2.2121E-04 | 5.123E+02 | 434 | 113 | 207 | 661 |
| | 3 | 11-15 | 9.2905E-04 | 3.3883E-08 | 5 | 1.8407E-04 | 5.123E+02 | 476 | 94 | 287 | 665 |
| | 4 | 16-20 | 5.9921E-04 | 2.8581E-07 | 5 | 5.3461E-04 | 5.123E+02 | 307 | 274 | -241 | 855 |
| 10A | 1 | 21-22 | 2.4709E-04 | 1.8345E-08 | 2 | 1.3544E-04 | 5.203E+02 | 129 | 70 | -12 | 270 |
| | 2 | 16-20 | 4.9313E-04 | 1.8345E-08 | 5 | 1.3544E-04 | 5.203E+02 | 257 | 70 | 116 | 398 |
| | 3 | 11-15 | 5.6857E-04 | 3.2342E-09 | 5 | 5.6870E-05 | 5.203E+02 | 296 | 30 | 237 | 355 |
| | 4 | 6-10 | 2.7357E-04 | 2.6969E-08 | 5 | 1.6422E-04 | 5.203E+02 | 142 | 85 | -29 | 313 |
| | 5 | 1-5 | 1.5529E-04 | 2.4596E-09 | 5 | 4.9594E-05 | 5.203E+02 | 81 | 26 | 29 | 132 |
| 9 | 1 | 1-5 | 2.3036E-04 | 1.6376E-08 | 5 | 1.2797E-04 | 5.047E+02 | 116 | 65 | -13 | 245 |
| | 2 | 6-10 | 2.0848E-04 | 1.6145E-08 | 5 | 1.2706E-04 | 5.047E+02 | 105 | 64 | -23 | 233 |
| | 3 | 11-15 | 2.7603E-04 | 6.5877E-09 | 5 | 8.1165E-05 | 5.047E+02 | 139 | 41 | 57 | 221 |

Continued

Appendix Table 35. Hydroacoustic estimate of fish inhabiting Area 1, Kenai Lake, Alaska based on Transect 6 (day survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|-------------------------------|
| 2.0 - 7.0 | 3.8520E+07 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 7 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 7.0 - 12.0 | 3.7560E+07 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 7 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 12.0 - 17.0 | 3.4890E+07 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 2.0120E-06 | 7 | 4.0050E-12 | 9.2860E-04 | 3.2397E+04 | 1.0420E+09 6.3250E+04 |
| 17.0 - 22.0 | 2.9980E+07 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 5.4830E-08 | 7 | 3.0060E-15 | 2.5300E-05 | 7.5863E+02 | 5.7740E+05 1.4890E+03 |
| 22.0 - 27.0 | 2.3380E+07 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 6 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 27.0 - 32.0 | 7.1730E+06 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 4 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 32.0 - 37.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 37.0 - 42.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 42.0 - 47.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 47.0 - 52.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 52.0 - 57.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 57.0 - 62.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 62.0 - 67.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 67.0 - 72.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 72.0 - 77.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 77.0 - 82.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 82.0 - 87.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 87.0 - 92.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 92.0 - 97.0 | 0.0000E+00 | 5.5870E-06 | 222 | 4.7730E-06 | 4.6150E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 1.7150E+08 | | | | | | | | 3.3156E+04 | + DR - | 6.3270E+04 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 7.7200E+06.

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 37. Hydroacoustic estimate of fish inhabiting Area 2, Kenai Lake, Alaska based on Transect 9 (day survey) integrator output.¹

| ² Depth Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Confidence Limits (95%) |
|---|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|-------------------------------|
| 2.0 - 7.0 | 5.9240E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 3.7210E-06 | 12 | 1.1060E-11 | 1.8780E-03 | 1.1127E+05 | 9.8980E+09 |
| 7.0 - 12.0 | 5.7500E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 2.3580E-06 | 12 | 5.3710E-12 | 1.1900E-03 | 6.8450E+04 | 4.5290E+09 |
| 12.0 - 17.0 | 5.3530E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 3.5040E-07 | 12 | 3.7080E-14 | 1.7690E-04 | 9.4683E+03 | 2.7150E+07 |
| 17.0 - 22.0 | 4.6990E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 2.0170E-08 | 10 | 4.0690E-16 | 1.0180E-05 | 4.7841E+02 | 2.2910E+05 |
| 22.0 - 27.0 | 4.2120E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 3.6570E-08 | 9 | 1.1540E-15 | 1.8460E-05 | 7.7745E+02 | 5.2240E+05 |
| 27.0 - 32.0 | 3.9290E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 1.2770E-07 | 9 | 5.5640E-15 | 6.4440E-05 | 2.5318E+03 | 2.1930E+06 |
| 32.0 - 37.0 | 3.8000E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 2.8150E-08 | 8 | 2.8180E-16 | 1.4210E-05 | 5.3996E+02 | 1.0390E+05 |
| 37.0 - 42.0 | 3.6540E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 42.0 - 47.0 | 3.5490E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 1.1820E-07 | 8 | 1.3510E-14 | 5.9680E-05 | 2.1181E+03 | 4.3400E+06 |
| 47.0 - 52.0 | 3.4480E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 7.6260E-08 | 8 | 5.6220E-15 | 3.8490E-05 | 1.3270E+03 | 1.7040E+06 |
| 52.0 - 57.0 | 3.3990E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 57.0 - 62.0 | 3.3790E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 1.4910E-09 | 8 | 2.2220E-18 | 7.5250E-07 | 2.5426E+01 | 6.4710E+02 |
| 62.0 - 67.0 | 3.2340E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 67.0 - 72.0 | 3.1040E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 0.0000E+00 | 7 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 72.0 - 77.0 | 3.0320E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 1.0910E-09 | 7 | 1.1910E-18 | 5.5080E-07 | 1.6701E+01 | 2.7920E+02 |
| 77.0 - 82.0 | 2.9380E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 1.7570E-10 | 7 | 3.0860E-20 | 8.8660E-08 | 2.6046E+00 | 6.7900E+00 |
| 82.0 - 87.0 | 2.6290E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 3.0810E-10 | 6 | 9.4950E-20 | 1.5550E-07 | 4.0882E+00 | 1.6730E+01 |
| 87.0 - 92.0 | 2.2100E+07 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 0.0000E+00 | 5 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 92.0 - 97.0 | 2.0690E+06 | 5.1080E-06 | 1172 | 5.2050E-06 | 5.0470E+02 | 0.0000E+00 | 5 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 6.8450E+08 | | | | | | | | 1.9701E+05 | + DR - | 2.3570E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.1910E+08.

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 39. Hydroacoustic estimate of fish inhabiting Area 3, Kenai Lake, Alaska based on Transect 11 (day survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Variance | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|------------|-------------------------------|
| 2.0 - 7.0 | 5.1200E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 1.9200E-05 | 10 | 2.4940E-10 | 1.1420E-02 | 5.8463E+05 | 2.3200E+11 | 9.4400E+05 |
| 7.0 - 12.0 | 5.0400E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 4.4290E-08 | 10 | 1.9610E-15 | 2.6340E-05 | 1.3274E+03 | 1.7660E+06 | 2.6040E+03 |
| 12.0 - 17.0 | 4.9690E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 2.2840E-08 | 10 | 5.2150E-16 | 1.3580E-05 | 6.7485E+02 | 4.5630E+05 | 1.3240E+03 |
| 17.0 - 22.0 | 4.9240E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 1.8020E-07 | 10 | 2.8320E-14 | 1.0720E-04 | 5.2788E+03 | 2.4340E+07 | 9.6710E+03 |
| 22.0 - 27.0 | 4.8940E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 10 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 27.0 - 32.0 | 4.8640E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 2.5990E-08 | 10 | 2.2490E-16 | 1.5460E-05 | 7.5202E+02 | 1.8930E+05 | 8.5280E+02 |
| 32.0 - 37.0 | 4.7970E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 2.2050E-07 | 10 | 4.8610E-14 | 1.3110E-04 | 6.2903E+03 | 3.9650E+07 | 1.2340E+04 |
| 37.0 - 42.0 | 4.7410E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 4.3950E-09 | 10 | 1.9310E-17 | 2.6140E-05 | 1.2393E+02 | 1.5390E+04 | 2.4310E+02 |
| 42.0 - 47.0 | 4.6840E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 10 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 47.0 - 52.0 | 4.6380E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 10 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 52.0 - 57.0 | 4.5880E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 9 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 57.0 - 62.0 | 4.4920E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 9 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 62.0 - 67.0 | 4.4270E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 9 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 67.0 - 72.0 | 4.3800E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 9 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 72.0 - 77.0 | 4.3140E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 9 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 77.0 - 82.0 | 4.2650E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 9 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 82.0 - 87.0 | 4.1870E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 9 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 87.0 - 92.0 | 4.0390E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 92.0 - 97.0 | 3.9610E+07 | 4.3350E-06 | 536 | 4.4310E-06 | 5.9470E+02 | 9.5250E-10 | 8 | 6.5590E-19 | 5.6650E-07 | 2.2437E+01 | 3.6490E+02 | 3.7440E+01 |
| TOTAL | 8.7324E+08 | | | | | | | | 5.9910E+05 | + OR - | 9.4410E+05 | |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.0540E+07.

² Depth measured below transducer, which was 1 m from surface.

Appendix Table 41. Hydroacoustic estimate of fish inhabiting Area 4, Kenai Lake, Alaska based on Transect 13 (day survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|-------------------------------|
| 2.0 - 7.0 | 7.1800E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 8.8920E-06 | 11 | 3.5520E-11 | 5.2030E-03 | 3.7358E+05 | 6.2810E+10 4.9120E+05 |
| 7.0 - 12.0 | 7.1830E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 3.6410E-08 | 11 | 1.3260E-15 | 2.1310E-05 | 1.5303E+03 | 2.3440E+06 3.0010E+03 |
| 12.0 - 17.0 | 7.1370E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 17.0 - 22.0 | 7.0960E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 22.0 - 27.0 | 6.9870E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 27.0 - 32.0 | 6.8850E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 32.0 - 37.0 | 6.7900E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 2.7840E-09 | 11 | 7.7490E-18 | 1.6290E-06 | 1.1061E+02 | 1.2250E+04 2.1690E+02 |
| 37.0 - 42.0 | 6.6790E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 42.0 - 47.0 | 6.5540E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 47.0 - 52.0 | 6.4320E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 52.0 - 57.0 | 6.3170E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 57.0 - 62.0 | 6.1990E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 11 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 62.0 - 67.0 | 5.9690E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 10 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 67.0 - 72.0 | 5.8230E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 10 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 72.0 - 77.0 | 5.6740E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 9 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 77.0 - 82.0 | 5.4350E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 82.0 - 87.0 | 5.3470E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| 87.0 - 92.0 | 5.2830E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 4.7160E-10 | 8 | 2.2240E-19 | 2.7600E-07 | 1.4578E+01 | 2.1270E+02 2.8590E+01 |
| 92.0 - 97.0 | 5.2430E+07 | 4.4060E-06 | 1525 | 4.8950E-06 | 5.8520E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 0.0000E+00 |
| TOTAL | 1.2021E+09 | | | | | | | | 3.7524E+05 | + OR - | 4.9120E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.4370E+07² Depth measured below transducer, which was 1 m from surface.

Appendix Table 43. Hydroacoustic estimate of fish inhabiting Area 5, Kenai Lake, Alaska based on Transect 15 (day survey) integrator output.¹

| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|----------------|-------------------------------|
| | | | | | | | | | | Variance | Fish Number | |
| 2.0 - 7.0 | 5.4580E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 3.3930E-05 | 8 | 2.5340E-10 | 1.6290E-02 | 8.8927E+05 | 1.8510E+11 | 8.4320E+05 |
| 7.0 - 12.0 | 5.4600E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 2.5380E-06 | 8 | 5.5720E-12 | 1.2190E-03 | 6.6546E+04 | 3.8910E+09 | 1.2230E+05 |
| 12.0 - 17.0 | 5.4590E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 9.0660E-08 | 8 | 5.0140E-15 | 4.3530E-05 | 2.3760E+03 | 3.5220E+06 | 3.6790E+03 |
| 17.0 - 22.0 | 5.4140E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 22.0 - 27.0 | 5.3500E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 2.3380E-07 | 8 | 2.3520E-14 | 1.1230E-04 | 6.0061E+03 | 1.6030E+07 | 7.8460E+03 |
| 27.0 - 32.0 | 5.2830E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 32.0 - 37.0 | 5.2170E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 37.0 - 42.0 | 5.1550E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 1.2110E-08 | 8 | 1.4670E-16 | 5.8150E-06 | 2.9974E+02 | 9.1100E+04 | 5.9160E+02 |
| 42.0 - 47.0 | 5.0980E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 47.0 - 52.0 | 5.0360E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 1.8230E-09 | 8 | 3.3220E-18 | 8.7510E-07 | 4.4069E+01 | 1.9690E+03 | 8.6970E+01 |
| 52.0 - 57.0 | 4.9530E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 57.0 - 62.0 | 4.8830E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 62.0 - 67.0 | 4.7920E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 67.0 - 72.0 | 4.6750E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 72.0 - 77.0 | 4.5670E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 77.0 - 82.0 | 4.4700E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 82.0 - 87.0 | 4.3110E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 87.0 - 92.0 | 4.1670E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 3.4510E-07 | 8 | 1.1910E-13 | 1.6570E-04 | 6.9042E+03 | 4.8330E+07 | 1.3630E+04 |
| 92.0 - 97.0 | 4.0570E+07 | 5.3700E-06 | 88 | 5.9470E-06 | 4.8010E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 9.3805E+08 | | | | | | | | 9.7145E+05 | + DR - | | 8.5220E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.0930E+07.

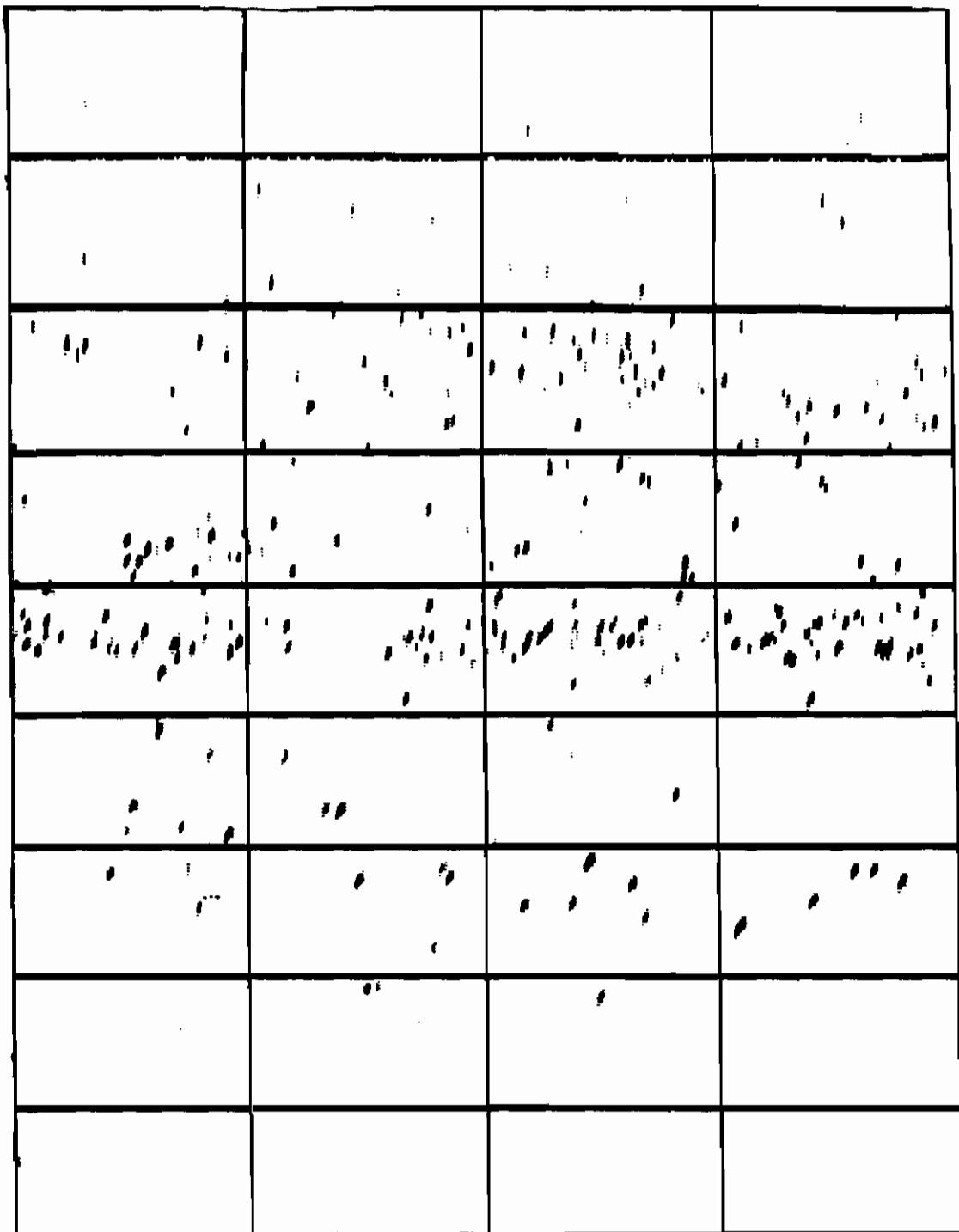
² Depth measured below transducer, which was 1 m from surface.

Appendix Table 45. Hydroacoustic estimate of fish inhabiting Area 5, Kenai Lake, Alaska based on Transect 18 (day survey) integrator output.¹

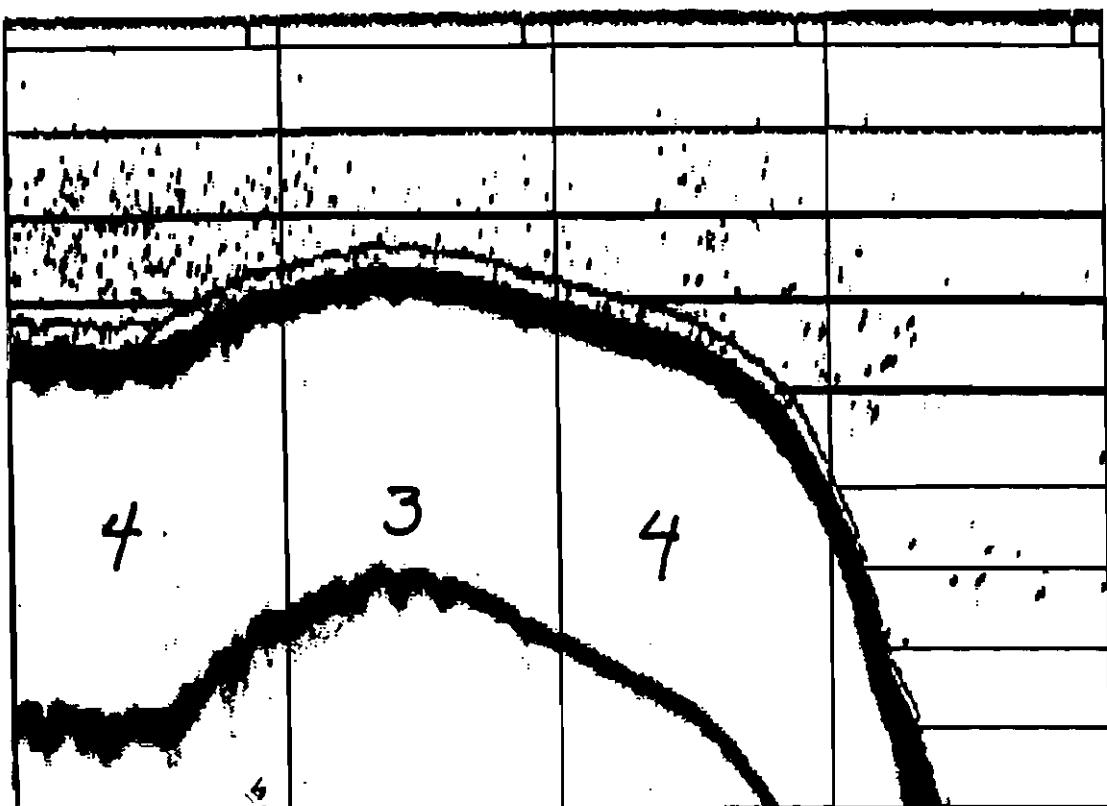
| Depth ² Stratum (m) | Stratum Volume (m ³) | Mean Sigma | Number Echoes Used | Standard Deviation Sigma | A Constant | Integrator Output | Number of Sequences | Mean Integrator Variance | Fish Density (no./m ³) | Estimated Number of Fish | Variance | Confidence Limits (95%) |
|--------------------------------------|--|---------------|--------------------------|--------------------------------|---------------|----------------------|---------------------------|--------------------------------|--|--------------------------------|------------|-------------------------------|
| 2.0 - 7.0 | 5.4520E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 4.4330E-06 | 8 | 9.3950E-12 | 1.2750E-03 | 6.9511E+04 | 2.6130E+09 | 1.0020E+05 |
| 7.0 - 12.0 | 5.3070E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 12.0 - 17.0 | 5.2010E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 8.1530E-07 | 8 | 2.8590E-13 | 2.3450E-04 | 1.2197E+04 | 7.3330E+07 | 1.6780E+04 |
| 17.0 - 22.0 | 5.1400E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 2.1680E-06 | 8 | 1.4520E-12 | 6.2360E-04 | 3.2052E+04 | 3.8170E+08 | 3.8290E+04 |
| 22.0 - 27.0 | 5.0630E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 1.7710E-06 | 8 | 1.1730E-12 | 5.0930E-04 | 2.5786E+04 | 2.9040E+08 | 3.3400E+04 |
| 27.0 - 32.0 | 4.9500E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 6.4270E-07 | 8 | 4.1310E-13 | 1.8490E-04 | 9.1501E+03 | 8.8980E+07 | 1.8490E+04 |
| 32.0 - 37.0 | 4.7780E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 8 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 37.0 - 42.0 | 4.6290E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 7 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 42.0 - 47.0 | 4.4620E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 7 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 47.0 - 52.0 | 4.2970E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 1.0830E-08 | 7 | 1.1740E-16 | 3.1150E-06 | 1.3389E+02 | 1.9050E+04 | 2.7050E+02 |
| 52.0 - 57.0 | 4.0680E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 7 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 57.0 - 62.0 | 3.8200E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 6 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 62.0 - 67.0 | 3.5980E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 6 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 67.0 - 72.0 | 3.3360E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 6 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 72.0 - 77.0 | 2.7880E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 6 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 77.0 - 82.0 | 1.7310E+07 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 5 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 82.0 - 87.0 | 4.1660E+06 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 2 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 87.0 - 92.0 | 0.0000E+00 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| 92.0 - 97.0 | 0.0000E+00 | 8.9640E-06 | 28 | 1.1880E-05 | 2.8760E+02 | 0.0000E+00 | 0 | 1.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 | 0.0000E+00 |
| TOTAL | 6.9037E+08 | | | | | | | | | 1.4883E+05 | + DR - | 1.1510E+05 |

¹ Lake surface area (meters squared) used to calculate stratum volume was 1.09030E+07.

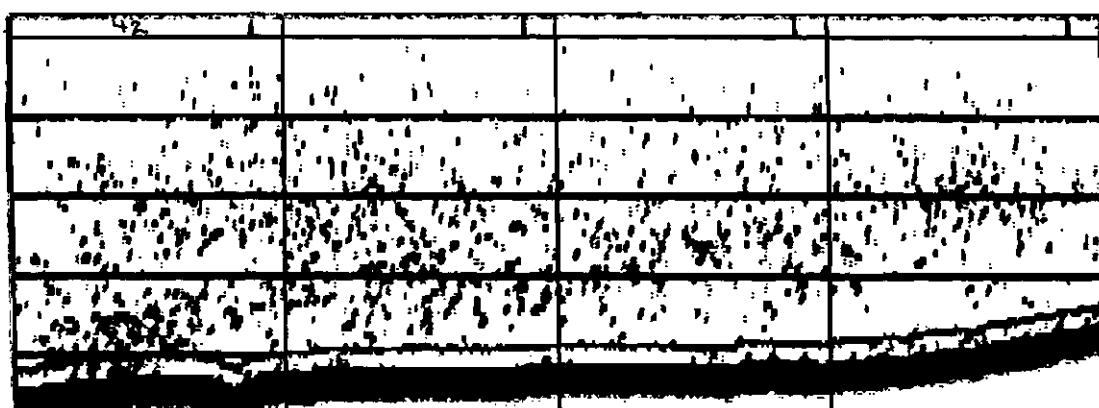
² Depth measured below transducer, which was 1 m from surface.



Appendix Figure 1. Echogram of transect 10A (one minute segments 9-12, depth interval 5m) in Kenai Lake (night survey), Alaska, September 1986.



Segments 15 to 17



Segments 42 to 45

Appendix Figure 3. Echogram of transect 1 (one minute segments 15-18 and 42-45, depth interval 5m) in Skilak Lake (night survey), Alaska, October 1986.

